This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

PROPERTY OF
University of
Michigan
Libraries
1817
ARTES SCIENTIA VERITAS

20.11

THE

RAY SOCIETY.

INSTITUTED MDCCCXLIV.

This volume is issued to the Subscribers to the RAY SOCIETY *for the Year* 1904.

LONDON:

MDCCCCIV.

W R

A MONOGRAPH

OF THE

BRITISH DESMIDIACEÆ

illiam

BY

W. WEST, F.L.S.,

Ex-president of the Yorkshire Naturalists' Union;
Lecturer in Botany, Biology, and Bacteriology at the Technical College, Bradford;

AND

G. S. WEST, M.A., F.L.S., A.R.C.S.,

Professor of Natural History at the Royal Agricultural College, Cirencester;
Formerly Scholar and Hutchinson Research Student of St. John's College, Cambridge

VOLUME I

LONDON
PRINTED FOR THE RAY SOCIETY
1904

PRINTED BY ADLARD AND SON,
LONDON AND DORKING.

Botany-Sci lib
Wheldon + Wesley
3-31-36
31768
5 [illegible]

PREFACE.

During a long and continuous study of the Desmidiaceæ we have realised the pressing need of a British Monograph by means of which diligent and painstaking students may reasonably hope to identify the various species which they may happen to meet with in any part of the British Isles. We have no doubt that one of the principal reasons for the lack of persistent students of these beautiful plants has been the absence of a reliable British Monograph on the group. Therefore, when we were asked by the Council of the Ray Society to undertake the work, we consented with pleasure and with a determination to place the results of the investigations of many years at the disposal of such a useful Society.

The earliest recorded descriptions and figures of British Desmids are found in Dillwyn's 'British Confervæ,' 1809; Smith's 'English Botany,' 1790–1814; Greville's 'Scottish Cryptogamic Botany,' 1823–1828; Smith's 'English Botany,' edit. 2, 1844; and in Jenner's 'Flora of Tunbridge Wells,' 1845. Ralfs also published some of the results of his work in the 'Annals and Magazine of Natural History' from 1842 to 1845, and in the 'Transactions of the Botanical Society of Edinburgh' from 1843 to 1846. In 1845 a 'History of British Freshwater Algæ' was published by Hassall, and in this work 68 Desmids were described and figured. Hassall did not give the dimensions of the species, and both the text and figures are often very inaccurate. Three years later, in 1848, Ralfs' 'British Desmidieæ' appeared, and this book undoubtedly opened the eyes of British naturalists to the wondrous beauty of a neglected class of plants. At the same time it gave a stimulus to the study of microscopical botany, and Ralfs' book stands to-day as the only monograph extant containing accurate figures of these simple plants. In this classical volume Ralfs described and figured 162 species and 32 varieties of British Desmids, and 18 species and 4 varieties of other Algæ belonging to the genera *Ankistrodesmus*, *Pediastrum*, and *Scenedesmus*. These genera were at that time supposed to belong to the Desmidiaceæ. He also briefly included some 64 species of Desmids and 3 species of other Algæ which had been found in foreign countries.

From 1858 to 1885 a large series of notes and short papers by W. Archer appeared in the 'Proceedings of the Dublin Microscopical Society' and the 'Quarterly Journal of Microscopical Science,' and in 1861 the same writer contributed the article on the Desmidiaceæ for Pritchard's 'Infusoria.' These are unquestionably among the most valuable contributions to the literature of British Desmids, and clearly prove that Archer was second to none in his detailed acquaintance and clear insight into the structure and habits of these plants. It is a great pity that many of his preliminary notes were never followed by his promised detailed descriptions and figures, as in several instances they were too meagre to be of any value.

Barker (1869), Bennett (1886–7), Bisset (1884), Cooke and Wills (1880–1), Marquand (1882–4), and Turner (1885–6) also contributed short papers on British Desmids, which added considerably to the knowledge of the distribution of the Desmidiaceæ in the British Islands.

In 1887 M. C. Cooke issued his 'British Desmids.' A good work was much needed at that time, but the book which then appeared was most unsatisfactory to scientific botanists, whatever it may have been to microscopists. In the first place, it was evident that very little Desmid-material had been examined, and, secondly, that scarcely any attempt had been made to collect together what was already known concerning the distribution of Desmids in the British Isles. Added to this, the illustrations were mostly very diagrammatic and many extraordinarily inaccurate. Often when a cell had been figured showing the cell-contents, the outline of the same figure was made to do duty for an empty cell, the latter being shown without its characteristic and indispensable markings. Not many (probably not more than a dozen in all) of the figures were original, and one of the remarks in the text called forth an article in the 'Journal of Botany' 1887, xxv, pp. 355–358, by Dr. O. Nordstedt of Lund, Sweden, who indicated the various works from which the figures had been roughly copied. Notwithstanding all these defects there is no doubt that the book was of value in stimulating students to further work on these plants. The number of species Cooke described was 271 with 46 varieties; there were also 19 species and 2 varieties in a supplement, making a total of 290 species and 48 varieties.

Since the publication of Cooke's book many papers have been issued concerning British Desmids. Several have appeared by Bennett, Roy, and Turner, and also a very good and comprehensive account of 'The Scottish Desmidieæ' by Roy and Bisset. The latter paper includes all the published information on Scottish Desmids up to 1894.

During the last fifteen years many papers have been published by continental botanists on Desmids from various parts of the world. The principal contributors to Desmid-literature have been Wille in Norway, Wittrock, Nordstedt, Borge, and Lagerheim in Sweden; Börgesen in Denmark; Schmidle and Lemmermann in Germany; Lütkemüller in Austria; Gutwinski in Poland; Gay in France; and Johnson in North America. Many of the works of these authors have been up to the present absolutely indispensable to students of British Desmids, and some of them will always remain so.

In the present monograph we have endeavoured to bring together all the published information concerning British Desmids that we have already mentioned, also much work which we have ourselves published concerning these plants, as well as a large number of hitherto unpublished investigations.

The number of species described and figured in the present work will be approximately 690, and the number of varieties about 450. This is an increase of 400 species and 402 varieties over those enumerated in the last monograph of British Desmids, by Cooke, the majority of which have been added by our own researches.

Although many months have been spent by us from year to year, investigating districts in almost all parts of the British Islands, large areas yet remain practically unworked. Under each species we give its distribution in the British Islands so far as it is known, and this will at once indicate the extensive and representative area which has been examined.

We also give the known geographical distribution of each species. It must be remembered, however, that our knowledge of the geographical distribution of Desmids is at present very incomplete.

Most of the figures are original, and much time and care has been expended on the drawing of the specimens in order that they should be as accurate as possible. In many instances we have given an accurate copy of the original figure published by the author of the species, but in all cases where the figures are not our own, mention has been made of the fact. In some cases where we have not had a drawing of a British specimen in a convenient form for reproduction, we have not hesitated to give a figure of a foreign specimen, provided the latter was typical. We regret very much that the figures are not drawn to a uniform scale of magnification, but the great diversity of size, and of firmness and structure of cell-wall exhibited throughout the family, together with the fact that we have reproduced a large number of the original figures of various authors, has rendered such uniformity of magnification impossible. Moreover, many species vary very considerably in their dimensions, so that relative size is of *no fundamental importance* as a specific distinction. Hence, it does not matter what the magnification of the drawing is, provided the scale is large enough to show all the distinctive features of the species. We think, however, that the student will soon become acquainted with the relative sizes of these plants, and we have endeavoured to make the measurements in the text as accurate as possible. All measurements are given in micromillimetres (μ). 1 μ=0·001 mm. Every species is drawn to scale and the magnification is indicated.

The note of exclamation (!) indicates that we have seen a specimen from the locality after which it is placed.

W. & G. S. WEST.

31*st May,* 1904.

CONTENTS OF VOL. I.

PAGE

BIBLIOGRAPHY xvii

INTRODUCTION 1

PHYLOGENY OF THE GENERA OF DESMIDS . . . 22

ORDER CONJUGATÆ 23

FAMILY DESMIDIACEÆ 23

- SUB-FAMILY I. SACCODERMÆ 29
  - TRIBE 1. GONATOZYGÆ 29
    - GENUS 1. GONATOZYGON 29
    - „ 2. GENICULARIA 35
  - TRIBE 2. SPIROTÆNIEÆ 37
    - GENUS 3. SPIROTÆNIA 37
    - „ 4. MESOTÆNIUM 48
    - „ 5. CYLINDROCYSTIS 57
    - „ 6. NETRIUM 63
- SUB-FAMILY II. PLACODERMÆ 70
  - TRIBE 3. PENIEÆ 71
    - GENUS 7. PENIUM 71
  - TRIBE 4. CLOSTERIÆ 106
    - GENUS 8. ROYA 106
    - „ 9. CLOSTERIUM 109
  - TRIBE 5. COSMARIEÆ 192
    - GENUS 10. DOCIDIUM 193
    - „ 11. PLEUROTÆNIUM . . . 197
    - „ 12. TETMEMORUS 216

ERRATA.

P. 39, line 28, for *musicola* read *muscicola.*

P. 160, line 28, in description of *Closterium toxon, delete* scattered.

LIST OF THE PLATES.

PLATE I.

Figs. 1-7.—*Gonatozygon monotænium* (p. 30)
„ 8-16.—*G. Brébissonii* (p. 31)
„ 17-18.—*G. Kjellmani* (p. 33)
„ 19-20.—*G. pilosum* (p. 34)

PLATE II.

Figs. 1-3.—*Gonatozygon Kinahani* (p. 35)
„ 4-6.—*Genicularia spirotænia* (p. 36)
„ 7-10.—*Spirotænia condensata* (p. 38)
„ 11.—*Sp. turfosa* (p. 42)
„ 12-14.—*Sp. fusiformis* (p. 43)
„ 15-18.—*Sp. parvula* (p. 43)
„ 19.—*Sp. closteridia* (p. 39)
„ 20-23.—*Sp. endospira* (p. 39)
„ 24-26.—*Sp. truncata* (p. 40)

PLATE III.

Figs. 1-3.—*Spirotænia minuta* (p. 41)
„ 4-6.—*Sp. eboracensis* (p. 42)
„ 7-12.—*Sp. obscura* (p. 44)
„ 13.—*Sp. bispiralis* (p. 45)
„ 14-15.—*Sp. acuta* (p. 46)
„ 16-17.—*Sp. tenerrima?* (p. 47)
„ 18-22.—*Mesotænium De Greyi* (p. 49)
„ 23-24.—*M. Kramstai* (p. 57)
„ 25-26.—*M. purpureum* (p. 55)
„ 27-33.—*M. violascens* (p. 55)
„ 34-36.—*M. macrococcum* (p. 51)

PLATE IV.

Figs. 1-3.—*Mesotænium macrococcum* (p. 52)
„ 4-14.—*M. chlamydosporum* (p. 52)
„ 15-17.—*M. caldariorum* (p. 53)
„ 18-19.—*M. mirificum* (p. 50)
„ 20-22.—*M. Endlicherianum* (p. 56)
„ 23-32.—*Cylindrocystis Brébissonii* (p. 58)
„ 33-38.—*C. crassa* (p. 59)
„ 39.—*C. roseola* (p. 62)
„ 40-43.—*C. diplospora* (p. 61)

PLATE V.

Figs. 1-2.—*Genicularia elegans* (p. 36)
„ 3-4.—*G. spirotænia* (p. 36)
„ 5.—*Gonatozygon monotænium* (p. 30)
„ 6.—*Spirotænia trabeculata* (p. 45)
„ 7.—*Netrium oblongum* (p. 66)
„ 8.—*Cylindrocystis obesa* (p. 60)
„ 9.—*C. minutissima* (p. 62)
„ 10-11.—*C. Brébissonii* (p. 58)
„ 12.—*Mesotænium truncatum* (p. 54)

PLATE VI.

Figs. 1-3.—*Penium Cylindrus* (p. 84)
„ 4-5.—*P. cuticulare* (p. 85)
„ 6-8.—*P. exiguum* (p. 86)

Plate VI—*continued.*

Figs. 9-11.—*P. phymatosporum* (p. 91)
„ 12-13.—*P. rufescens* (p. 99)
„ 14-17.—*Netrium Digitus* (p. 64)

Plate VII.

Figs. 1-3.—*Netrium interruptum* (p. 68)
„ 4-5.—*N. Nägelii* (p. 66)
„ 6-11.—*Penium Libellula* (p. 73)
„ 12-19.—*P. Navicula* (p. 75)
„ 20-21.—*P. Jenneri* (p. 77)

Plate VIII.

Figs. 1-3.—*Netrium oblongum* (p. 66)
„ 4-5.—*Penium crassiusculum* (p. 96)
„ 6-7.—*P. spinospermum* (p. 78)
„ 8-10.—*P. Mooreanum* (p. 80)
„ 11-13.—*P. didymocarpum* (p. 79)
„ 14-19.—*P. suboctangulare* (p. 81)
„ 20-23.—*P. minutissimum* (p. 81
„ 24-26.—*P. truncatum* (p. 82)
„ 27-29.—*P. subtile* (p. 92)
„ 30-31.—*P. adelochondrum* (p. 93)
„ 32-35.—*P. margaritaceum* (p. 83)
„ 36-38.—*P. Clevei* (p. 87)
„ 39.—*P. granulatum* (p. 87)

Plate IX.

Figs. 1-8.—*Penium spirostriolatum* (p. 88)
„ 9-11.—*P polymorphum* (p. 90)
„ 12.—*P. lagenarioides* (p. 93)
„ 13-20.—*P. Cucurbitinum* (p. 94)

Plate X.

Figs. 1-14.—*Penium minutum* (p. 101)
„ 15-17 *P. inconspicuum* (p. 101)
„ 18-20.—*P. cruciferum* (p. 100)
„ 21-26.—*P. curtum* (p. 97)
„ 27-29.—*Roya obtusa* (p. 107)
„ 30.—*R. Pseudoclosterium* (p. 109)
„ 31.—*R. Cambrica* (p. 108)

Plate XI.

Figs. 1-4.—*Closterium Cynthia* (p. 113
„ 5-7.—*Cl. Lagoense* (p. 114)
„ 8-11.—*Cl. Archerianum* (p. 115)
„ 12-13.—*Cl. porrectum* (p. 116)

Plate XII.

Figs. 1-7.—*Closterium didymotocum* (p. 116)
„ 8-10.—*Cl. macilentum* (p. 118)
„ 11-13.—*Cl. angustatum* (p. 119)

Plate XIII.

Figs. 1-3.—*Closterium costatum* (p. 120)
„ 4-6.—*Cl. regulare* (p. 122)
„ 7-17.—*Cl. striolatum* (p. 122)

Plate XIV.

Figs. 1-6.—*Closterium intermedium* (p. 125)
„ 7-9.—*Cl. Ulna* (p. 127)
„ 10-16.—*Cl. juncidum* (p. 128)

Plate XV.

Figs. 1-6.—*Closterium Dianæ* (p. 130)
„ 7-8.—*Cl. Pseudodianæ* (p. 132)
„ 9-14.—*Cl. parvulum* (p. 133)

Plate XV—*continued.*

Figs. 15-20.—*Cl. Venus* (p. 137)
,, 21-22.—*Cl. Dianæ* (p. 130)
,, 23-27.—*Cl. Jenneri* (p. 134)
,, 28-30.—*Cl. incurvum* (p. 136)

Plate XVI.

Figs. 1-6.—*Closterium calosporum* (p. 138)
,, 7-8.—*Cl. eboracense* (p. 140)
,, 9-14.—*Cl. Leibleinii* (p. 141)
,, 15-16.—*Cl. moniliferum* (p. 142)

Plate XVII.

Figs. 1-4.—*Closterium Ehrenbergii* (p. 143)
,, 5-6.—*Cl. Malinvernianum* (p. 145)
,, 7-8.—*Cl. decorum* (p. 184)
,, 9-11.—*Cl. lanceolatum* (p. 149)

Plate XVIII.

Figs. 1-6.—*Closterium acerosum* (p. 146)
,, 7.—*Cl. lanceolatum* (p. 149)
,, 8-12.—*Cl. Lunula* (p. 150)

Plate XIX.

Figs. 1-5.—*Closterium sigmoideum* (p. 153)
,, 6-8.—*Cl. Siliqua* (p. 154)
,, 9-13.—*Cl. peracerosum* (p. 154)
,, 14.—*Cl. littorale* (p. 155)
,, 15-18.—*Cl. tumidum* (p. 156)

Plate XX.

Figs. 1-5.—*Closterium Cornu* (p. 157)
,, 6-12.—*Cl. abruptum* (p. 158)
,, 13-14.—*Cl. toxon* (p. 160)
,, 15-16.—*Cl. Balmacarense* (p. 161)

Plate XX—*continued.*

Figs. 17-18.—*Cl. Scoticum* (p. 161)
,, 19- .—*Cl. pusillum* (p. 162)

Plate XXI.

Figs. 1-5.—*Closterium prælongum* (p. 164)
,, 6-7.—*Cl. strigosum* (p. 165)
,, 8-16.—*Cl. gracile* (p. 166)
,, 17.—*Cl. Lundellii* (p. 169)
,, 18-19.—*Cl. aciculare* (p. 174)

Plate XXII.

Figs. 1-3.—*Closterium attenuatum* (p. 169)
,, 4-5.—*Cl. turgidum* (p. 170)
,, 6-14.—*Cl. Pritchardianum* (p. 172)

Plate XXIII.

Figs. 1-3.—*Closterium pronum* (p. 173)
,, 4-5.—*Cl. aciculare* (p. 174)
,, 6-8.—*Cl. Ceratium* (p. 176)
,, 9-15.—*Cl. acutum* (p. 177)
,, 16-19.—*Cl. subulatum* (p. 179)
,, 20-21.—*Cl. idiosporum* (p. 180)

Plate XXIV.

Figs. 1-5.—*Closterium lineatum* (p. 181)
,, 6-13.—*Cl. Ralfsii* (p. 182)

Plate XXV.

Figs. 1-3.—*Closterium decorum* (p. 184)
,, 4-5.—*Cl. laterale* (p. 186)
,, 6-13.—*Cl. Kützingii* (p. 186)

Plate XXVI.

Figs. 1-8.—*Closterium rostratum* (p. 188)
,, 9-13.—*Cl. setaceum* (p. 190)

PLATE XXVII.

Figs. 1-6.—*Docidium Baculum* (p. 193)
" 7-12.—*D. undulatum* (p. 194)
" 13-15.—*D. nobile* (p. 196)
" 16-18.—*Pleurotænium coronatum* (p. 199)

PLATE XXVIII.

Figs. 1-8.—*Pleurotænium coronatum* (p. 199)

PLATE XXIX.

Figs. 1-2.—*Pleurotænium eugeneum* (p. 202)
" 3-8.—*Pl. truncatum* (p. 203)
" 9-11.—*Pl. Ehrenbergii* (p. 205)

PLATE XXX.

Figs. 1-4.—*Pleurotænium Ehrenbergii* (p. 205)
" 5-8.—*Pl. tridentulum* (p. 208)
" 9-15.—*Pl. Trabecula* (p. 209)

PLATE XXXI.

Figs. 1-2 —*Pleurotænium maximum* (p. 213)
" 3-6.—*Pl. nodosum* (p. 214)
" 7.—*Pl. Hutchinsonii* (p. 214)
" 8-9.—*Pl. Trabecula* (p. 209)

PLATE XXXII.

Figs. 1-6.—*Tetmemorus Brébissonii* (p. 216)
" 7-10.—*T. granulatus* (p. 219)
" 11-16.—*T. lævis* (p. 222)
" 17-19.—*T. minutus* (p. 223)

BIBLIOGRAPHY.

ANDERSS. *Sverig. Chlor.*—O. Fr. Andersson, Bidrag till Kannedomen om Sveriges Chlorophyllophyceer. I. Chlorophyllophyceer från Roslagen. Bihang till K. Sv. Vet.-Akad. Handl. xvi, no. 5, 1890.

ARCH. *Suppl. Cat. Desmid.*—W. Archer, Supplementary Catalogue of Desmidiaceæ found in the neighbourhood of Dublin, etc. Nat. Hist. Rev. (Proc.) v, 1858.

ARCH. *in Pritch. Infus.*—W. Archer in A. Pritchard's History of Infusoria; (Desmidieæ by W. Archer). Edit. 4. London, 1861.

ARCH. *Descript. New Cosm., etc.*—W. Archer, Description of a new Species of *Cosmarium* (Corda), of *Staurastrum* (Meyen), of two new Species of *Closterium* (Nitzsch), and of *Spirotænia* (Bréb.). Proc. Dubl. Nat. Hist. Soc. iii, part 2, 1863.

ARCH. *Palmoglœa and descrip. Mesot.*—W. Archer, An Endeavour to identify *Palmoglœa macrococca* (Kütz.), with description of plant believed to be meant, and of a new species, etc. Description of a new Species of *Cosmarium* and of *Arthrodesmus*. Proc. Dubl. Nat. Hist. Soc. iv, part 1, 1864.

ARCH. *Observations on Cylindrocystis.*—W. Archer, Observations on the genera *Cylindrocystis* (Meneghini), *Mesotænium* (Näg.), and *Spirotænia* (Bréb.), etc. Quart. Journ. Micr. Sci. n.s. vi, 1866.

ARCH. *Conj. Spirotæn.*—W. Archer, On the Conjugation of *Spirotænia condensata* (Bréb.) and *Spirotænia truncata* (Arch.). Quart. Journ. Micr. Sci. n.s. vii, July, 1867.

ARCH. *in Quart. Journ. Micr. Sci.*—W. Archer, Numerous notes and papers in the Quarterly Journal of Microscopical Science, from 1858 to 1885.

Bail. *Microscop. Observ.*—J. W. Bailey, Microscopical observations made in South Carolina, Georgia, and Florida. Smithson. Contrib. to Knowledge, ii, 1850 & 1851.

Barker *in Quart. Journ. Micr. Sci.*—J. Barker, Several notes in the Quarterly Journal of Microscopical Science, from 1866 to 1873.

Benn. *Freshw. Alg. Eng. Lake Distr.*—A. W. Bennett, Freshwater Algæ (including Chlorophyllaceous Protophyta) of the English Lake District, etc. Journ. Roy. Micr. Soc. 1886.

Benn. *Freshw. Alg. Eng. Lake Distr. II.*—A. W. Bennett, Freshwater Algæ (including Chlorophyllous Protophyta) of the English Lake District. II. With descriptions of a new genus and five new species. Journ. Roy. Micr. Soc. 1888.

Benn. *Alg. N. Cornwall.*—A. W. Bennett, Freshwater Algæ (including Chlorophyllaceous Protophyta) of North Cornwall; with descriptions of six new species. Journ. Roy. Micr. Soc. 1887.

Benn. *Freshw. Alg. Hamps. and Devon.*—A. W. Bennett, Freshwater Algæ and Schizophyceæ of Hampshire and Devonshire. Journ. Roy. Micr. Soc. 1890.

Benn. *Freshw. Alg. S.W. Surrey.*—A. W. Bennett, Freshwater Algæ and Schizophyceæ of S.W. Surrey. Journ. Roy. Micr. Soc. 1892.

Biss. *Desm. Windermere.*—J. P. Bissett, List of Desmidieæ found in gatherings made in the neighbourhood of Lake Windermere during 1883. Journ. Roy. Micr. Soc. 1884.

Bohlin, *Flor. Algol. d'eau douce d. Açores.*—K. Bohlin, Etude sur la flore algologique d'eau douce des Açores. Bih. till K. Sv. Vet.-Akad. Handl. xxvii, Afd. III, no. 4, 1901.

Boldt, *Siber. Chlorophy.*—R. Boldt, Bidrag till Kännedomen om Siberiens Chlorophyllophyceer. Öfvers. af K. Vet.-Akad. Förhandl. 1885, no. 2.

Boldt, *Desmid. Grönland.*—R. Boldt, Desmidieer från Grönland. Bihang till K. Sv. Vet.-Akad. Handl. xiii, no. 5, 1888.

Börg. *Bornholm. Desm.-fl.*—F. Börgesen, Et lille Bidrag till Bornholms Desmidié-flora. Botan. Tidsskrift, xvii, 1889.

Börg. *Desm. Brasil.*—F. Börgesen, Desmidieæ in E. Warming, Symbolæ ad floram Brasiliæ centralis cognoscendam, part 34, 1890; publ. in Vidensk. Medd. f. naturh. Foren. Kjöbenhavn, 1890.

Börg. *Ferskv. alg. Östgrönl.*—F. Börgesen, Ferskvandsalger fra Östgrönländ. Meddelelser om Grönland, Kjöbenhavn, 1894.

Börg. *Ferskv. Alg. Island.*—F. Börgesen, Nogle Ferskvandsalger fra Island. Botanisk Tidsskrift. xxii, Heft. 2, 1898.

Börg. *Freshw. Alg. Færöes.*—F. Börgesen, Freshwater Algæ of the Faeröes. Botany of the Faeröes, part 1, Copenhagen, 1901.

Börg. & Ostenf. *Phytoplankton Færöes.*—F. Börgesen and C. H. Ostenfeld, Phytoplankton of Lakes in the Faeröes. Botany of the Faeröes, 1903.

Borge, *Bidr. Siber. Chlor.*—O. Borge, Ett litet bidrag till Siberiens Chlorophyllophycé-flora. Bih. till K. Sv. Vet.-Akad. Handl. xvii, Afd. III, no. 2, 1891.

Borge, *Chlor. Norska Finmark.*—O. Borge, Chlorophyllophyceer från Norska Finmarken. Bih. till K. Sv. Vet.-Akad. Handl. xvii, Afd. III; no. 4, 1892.

Borge, *Subfoss. sötv. alg. Gotl.*—O. Borge, Subfossila sötvattensalger från Gotland. Botan. Notiser, 1892.

Borge, *Süssw. Chlor. Archang.*—O. Borge, Süsswasser-Chlorophyceen gesammelt von Dr. A. Osw. Kihlman in Nördlichsten Russland, gouvernement Archangel. Bih. till K. Sv. Vet.-Akad. Handl. xix, Afd. III, no. 5, 1894.

Borge, *Austral. Süsswasserchlor.*—O. Borge, Australische Süsswasserchlorophyceen. Bihang till K. Sv. Vet.-Akad. Handl. xxii, no. 9, 1896.

Borge, *Variabil. Desmid.*—O. Borge, Ueber die Variabilitat der Desmidiaceen. Öfvers. af K. Sv. Vet.-Akad. Förh. 1896, no. 4.

Borge, *Algologiska Notiser.*—O. Borge, Algologiska Notiser. 4. Süsswasser-Plankton aus der Insel Mull. Botan. Notiser, 1897.

Borge, *Trop. u. subtrop. Süssw.-Chlor.*—O. Borge, Ueber tropische und subtrophische Süsswasser-Chlorophyceen. Bih. till K. Sv. Vet.-Akad. Handl. xxiv, Afd. III, no. 12, 1899.

Borge, *Süsswasseralgen Franz Josefs-Land.*—O. Borge, Süsswasseralgen von Franz Josefs-Land, gesammelt von der Jackson-Harmsworth'schen Expedition. Öfvers. af K. Vet.-Akad. Förh. 1899, no. 7.

Borge, *Schwed. Süsswasserplankton.*—O. Borge, Schwedisches Süsswasserplankton. Botaniska Notiser, 1900.

Borge, *Süsswasseralgen Süd-Patagon.*—O. Borge, Süsswasseralgen aus Süd-Patagonien. Bih. till K. Sv. Vet.-Akad. Handl. xxvii, Afd. III, no. 10, 1901.

Borge, *Alg. erst. Regnell. Exped., II. Desmid.*—O. Borge, Die Algen der ersten Regnellschen Expedition. II. Desmidiaceen. Arkiv. för Botanik, K. Sv. Vet.-Akad. Stockholm. i, 1903.

Bréb. *Alg. Falaise.*—A. de Brébisson, Algues des environs de Falaise descrites et dessinées. Falaise 1835. Mem. de la Soc. Acad. d. sc. arts et bell. lettr. de Falaise, 1835.

Bréb. *in Cheval. microscop. et usage.*—A. de Brébisson, Sur les preparations nécessaires à l'étude das Algues inferieures, etc. Cheval. Des microscop. et de leur usage, Paris, 1839.

Bréb. *in Dict. univ. hist. nat.*—A. de Brébisson, in Dictionnaire universelle d'histoire naturelle. (Dirigé par C. d'Orbigny.) Paris, 1842–49.

Bréb. *Liste Desm.*—A. de Brébisson, Liste des Desmidiées, observées en Basse-Normandie. Mem. d. l. soc. imp. des Sciences nat. de Cherbourg. iv, 1856.

Cleve, *Sverig. Desm.*—P. T. Cleve, Bidrag till Kännedomen om Sveriges söttvattensalger af familjen Desmidieæ. Öfvers. af K. Vet.-Akad. Förh. 1863, no. 10. (Stockholm, 1864.)

Cohn, *Desm. Bongo.*—F. Cohn, Desmidiaceæ Bongoenses. Festschrift zur Feier des hundertjähr. Bestehens der Naturf. Ges. in Halle a S. 1879.

Comère, *Desm. de France.*—J. Comère, Les Desmidiées de France. Paris, 1901.

Cooke, *Some Desm. new to Britain.*—M. C. Cooke, On some Desmids new to Britain. Journ. Quek. Micr. Club. vi, March, 1881.

Cooke, *Brit. Desm.*—M. C. Cooke, British Desmids. A supplement to British Freshwater Algæ. London, 1886–87.

Corda *in Alm. de Carlsbad.*—A. J. C. Corda in Almanach de Carlsbad par le chevalier Jean de Carro. Prague, 1834, 1835, 1839, and 1840.

De Bary, *in Hedwigia.*—De Bary, Zu Gonatozygon monotænium. Hedwigia I, 1856, no. 16.

De Bary, *Conj.*—De Bary, Untersuchungen über die Familie der Conjugaten (Zygnemeen und Desmidieen). Leipzig, 1858.

Delp. *Desm. subalp.*—J. B. Delponte, Specimen *Desmidiacearum subalpinarum.* Augustæ Taurinorum, 1873; Pars altera, ibid. 1877. Memor. d. R. Accad. d. scienze di Torino, ser. 2, xxviii and xxx.

De Not. *Desm. Ital.*—G. de Notaris, Elementi per lo studio delle Desmidiacee Italiche. Genoa, 1867.

De Toni, *Syll. Alg.*—G. B. de Toni, Sylloge Algarum omnium hucusque cognitarum. Vol. I. Chlorophyceæ. Patavii, 1889.

Ehrenb. *Beitr. zur Kenntniss der Organis. der Infus.*—C. G. Ehrenberg, Beiträge zur Kenntniss der Organisation der Infusorien und ihrer geographischen Verbreitung besonders in Siberien. Phys. Abhandl. d. K. Akad. d. Wissenschaft. zu Berlin. 1830.

Ehrenb. *Entwick. Lebends. d. Infus.*—C. G. Ehrenberg, Ueber die Entwickelung und Lebensdauer der Infusionsthiere, etc. Phys. Abh. d. K. Akad. d. Wissensch. zu Berlin, 1830. (Berlin, 1832.)

Ehrenb. *Infus.*—C. G. Ehrenberg, Die Infusionsthierchen als vollkommene Organismen. Leipzig, 1838.

Eichler, *Mat. flor. Miedz.*—B. Eichler, Materyaly do flory wodorostów okolic Międzyrzeca. Pamietnik Fizyjograficzny, Warszawa, xiii, Dzial iii, 1893, also xiv, 1894.

Eichler & Gutw. *Nonn. spec. alg. nov.*—B. Eichler and R. Gutwinski, De nonnullis speciebus algarum novarum. Rospraw Wydz. matem.-przyr. Akad. Umiej. Krakow. xxviii, 1894.

Elfv. *Anteck. Finska Desm.*—F. Elfving, Anteckningar om Finska Desmidieer. Acta Soc. pro Fauna et Flora Fennica, v, no. 2, 1881. Helsingfors.

Focke, *Phys. Stud.*—G. W. Focke, Physiologische Studien I H. Bremen 1847. 2 Heft, Bremen, 1854.

Forti, *Contrib.* 4°. *flor. ficolog. Veron.*—A. Forti, Contributo 4°. alla conoscenza della florula ficologica Veronese, 1902. Nuova Notarisia, ser. 13, 1902.

Fritsch, *Period. devel. of Algæ at Kew.*—F. E. Fritsch, Remarks on the periodical development of the Algæ in the artificial waters at Kew. Annals of Botany, xvii, Jan. 1903.

Gay, *Monogr. loc. Conj.*—F. Gay, Essai d'une monographie locale des Conjugées. (Thèse presentée et soutenue publiquement à l'Ecole superieure de Pharmacie de Montpellier. Febr. 1884.)

Gay, *Note Conj. du midi de France.*—F. Gay, Note sur les Conjugées du midi de la France. Bull. d. l. Soc. botanique de France, xxxi, 1884.

Gay, *Alg. Bagn. Bigorr.*—F. Gay, Algues de Bagnères-de-Bigorre. Bull. Soc. botan. France, xxxviii, 1891.

Grun. *Desm. u. Pediast. österreich. Moore.*—A. Grunow, Die Desmidiaceen und Pediastreen einiger österreichischen Moore. Verhand. d. zool. bot. Ges. in Wien, 1858.

Grun. *Diat. u. Desm. Ins. Bank.*—A. Grunow, Ueber die von Herrn Gerstenberger in Rabenhorst's Decaden ausgegebenen Süsswasser-Diatomaceen und Desmidiaceen von der Insel Banka. Beiträge zu näheren Kentniss und Verbreitung der Algen. Herausgegeben von L. Rabenhorst. Heft 2, Leipzig, 1865.

Gutw. *Wahr. d. Priorität.*—R. Gutwinski, Zur Wahrung der Priorität. Botanisches Centralblatt. xliii, 1890.

Gutw. *Flor. Glon. Okolic Lwowa.*—R. Gutwinski, Flora Glonów Okolic Lwowa. Spraw. Kom. fizyjogr. Akad. Umiej. Krakow. xxvii, 1891.

Gutw. *Flor. glonów Galic.*—R. Gutwinski, Materyaly do Flory glonów Galicyi. Spraw. Kom. fizyjogr. Akad. Umiej. Krakow. xxviii, 1892.

Gutw. *Flor. Glon. Okolic Tarnopola.*—R. Gutwinski, Flora Glonów Okolic Tarnopola. Spraw. Kom. fizyjogr. Akad. Umiej. Krakow. xxx, 1894.

Gutw. *Nagj. dosel. Bosni Hercegovin. halugam.*—R. Gutwinski, Onagjenim dosele u Bosni i Hercegovini halugama. Glasn. Zemaljs. Muz. Bosn. Hercegovin. viii, 1896.

Gutw. *Nonn. Alg. Nov.*—R. Gutwinski, De nonnullis algis novis vel minus cognitis. Rozpraw Wydz. matem.-przyr. Akad. Umiej. Krakow. xxxiii, 1896.

Gutw. *Wykaz. Glonow Wadow.-Makow.*—R. Gutwinski, Wykaz Glonów zebranych w okolicy Wadowic-Makowa. Spraw. Kom. fizyjog. Akad. Umiej. Krakow. xxxii, 1897.

Gutw. *Karlsbad Algen.*—R. Gutwinski, Ueber die in der Umgebung von Karlsbad im Juli 1898 gesammelten Algen. Botan. Centralblatt. lxxviii, no. 14, 1899.

Gutw. *Alg. Ins. Java.*—R. Gutwinski, De Algis a M. Raciborski anno 1899 in Insula Java collectis. Bull. Acad. des Sciences Cracovie. Nov. 1902.

Gutw. *Alg. Sakuplj. okolic. Travnick.*—R. Gutwinski, O Algama sakupljenima u okolici Travnickoj. Glasn. Zemaljs. Muz. Bosn. Hercegovin. xiv, 1902.

Gutw. *Alg., præcip. Diatom., Asia central. atque in China collect.*—R. Gutwinski, De Algis, præcipue Diatomaceis, a J. Holderer anno 1898 in Asia centrali atque in China collectis. Bull. Acad. des Sciences Cracovie. Avril, 1903.

Hansg. *in Oesterr. bot. Zeitschr.*—A. Hansgirg, Beiträge zur Kenntnis der Bergalgenflora Böhmens. Oesterr. bot. Zeitschr. xxxvii, 1887.

Hansg. *Prodr. Algenfl. Böhm.*—A. Hansgirg, Prodromus der Algenflora von Böhmen Prag. Theil Erst. 1888; Zweit. Theil 1892. Archiv. der naturwiss. Landesdurchf. von Böhmen, vi, no. 6; viii, no. 4.

Hass. *Brit. Freshw. Alg.*—A. H. Hassall, A History of the British Freshwater Algæ, vols. I and II. London, 1845.

Hast. *in Amer. Month. Micr. Journ.*—W. N. Hastings, New Desmids from New Hampshire. Amer. Month. Micr. Journ. xiii, 1892.

Hauptfl. *Zellmembr. u. Hüllgallerte Desm.*—P. Hauptfleisch, Zellmembran und Hüllgallerte der Desmidiaceen Inaugural-Dissert. Greifswald 1888. Mitth. a. d. Naturwiss. Ver. f. Neuvor-pommern u. Rügen. Jahrg. 20.

Heimerl, *Desm. alp.*—A. Heimerl, Desmidiaceæ alpinæ. Verhandl. der. k. k. zool.-botan. Gesellschaft Wien, xli, 1891.

Hieronymus, *Conj. in Engl. Pflanzenw. Ost.-Afrika.*—G. Hieronymus, "Conjugatæ" in Engler's Die Pflanzenwelt Ost.-Afrikas und der Nachbargebeite. Theil C. Berlin, 1895.

Istvanffi, *Diag. præv. Alg. nov. Hungar.*—G. Istvanffi (Schaarschmidt), Diagnoses præviæ Algarum novarum in Hungaria observatarum, etc. Notarisia, no. 5, 1887.

Itzigs. *apud Braun in Bot. Zeit.*—A. Braun, Beobachtungen des Dr. Itzigsohn in Neu-Damm über verschiedene mikroscopische Algen. Botanische Zeitung, Jan. 1856.

Jacobs. *Desm. Danem.*—J. P. Jacobsen, Aperçu systematique et critique sur les Desmidiacées du Danemark. Botanisk Tidsskrift, viii, 1874–75.

Johnson, *Species of Micrasterias.*—L. N. Johnson, On some species of Micrasterias. Botan. Gazette, xix, 1894.

Johnson, *Rare Desm. U.S., I.*—L. N. Johnson, Some New and Rare Desmids of the United States. Bull. Torrey Bot. Club. xxi, no. 7, July, 1894.

Johnson, *Rare Desm. U.S. II.*—L. N. Johnson, Some New and Rare Desmids of the United States II. Bull. Torrey Bot. Club. xxii, no. 7, July, 1895.

Josh. *Notes Brit. Desm. I.*—W. Joshua, Notes on British Desmidieæ. Journ. Bot. xx, Oct. 1882.

Josh. *Notes Brit. Desm. II.*—W. Joshua, Notes on British Desmidieæ—no. 2. Journ. Bot. xxi, Oct. 1883.

Josh. *New and Rare Desm.*—W. Joshua, On some new and rare Desmidieæ—no. 3. Journ. Bot. xxiii, Febr. 1885.

Josh. *Burmese Desm.*—W. Joshua, Burmese Desmidieæ, with descriptions of new species occurring in the neighbourhood of Rangoon. Journ. Linn. Soc. bot. xxi, 1886.

Kirchn. *Alg. Schles.*—O. Kirchner, Kryptogamen-flora von Schlesien. Zweit. Bd., Erste Hälfte. Algen. Breslau, 1878.

Kirchn. *Beitr. Algenfl. Würtemb.*—O. Kirchner, Beiträge zur Algenflora von Würtemburg. Jahreshefte d. Vereins f. vaterl. Naturkunde in Würtemburg, Jahrg. 36. Stuttgart, 1880.

Kirchn. *Flor. Phycolog. Benacensis.*—O. Kirchner, Florula Phycologica Benacensis. Civic. Mus. di Rovereto publicaz. xxxvi, 1899.

Klebs, *Desm. Ostpreuss.*—G. Klebs, Ueber die Formen einiger Gattungen der Desmidiaceen Ostpreussens. Schrift. d. physik.-œkonom. Gesellsch. zu Königsberg, V, 22, 1879.

Kuntze, *Revis. Gen Plant.*—O. Kuntze, Revisio generum plantarum vascularium omnium atque cellularium multarum secundum leges nomenclaturæ internationales etc. Pars I et II. Würzburg, 1891.

Kütz *Syn. Diat.*—F. T. Kützing, Synopsis Diatomacearum oder Versuch einer systematischen Zusammenstellung der Diatomeen. Halle, 1834. [Linnæa, viii, 1833.]

Kütz. *Phyc. germ.*—F. T. Kützing, Phycologia germanica, d. i. Deutschlands Algen in bündigen Beschreibungen. Nordhausen, 1845.

Kütz. *Tab. phycolog.*—F. T. Kützing, Tabulæ phycologicæ oder Abbildungen der Tange. vol. I, Nordhausen, 1847.

Kütz. *in Botan. Zeitung.*—F. T. Kützing, Diagnosen und Bemerkungen zu neuen oder Kritischen Algen. Botanische Zeitung, 1847, no. 13.

Kütz. *Spec. Alg.*—F. T. Kützing, Species Algarum. Lipsiæ, 1849.

Lagerh. *Bidr. Sverig. Algfl.*—G. Lagerheim, Bidrag till Sveriges algflora. Öfvers. af K. Vet.-Akad. Föhr. 1883, No. 2.

Lagerh. *Bidr. Amerik. Desm.-fl.*—G. Lagerheim, Bidrag. till Amerikas Desmidiéflora. Öfvers. af K. Vet.-Akad. Förh. 1885, no 7.

Lagerh. *Algol. Bidr.*—G. Lagerheim, Algologiska Bidrag. I Contributions algologique à la flore de la Suède. Botaniska Notiser, 1886.

Lagerh. *Krit. Bemerk. Desm.*—G. Lagerheim, Kritische Bemerkungen zu einigen in den letzten Jahren beschriebenen Arten und Varietäten von Desmidiaceen. Öfvers. af K. Vet.-Akad. Förh. 1887, no. 8.

Lagerh. *Desm. aus Bengal.*—G. Lagerheim, Ueber Desmidiaceen aus Bengalen nebst Bemerkungen über die Geographische Verbreitung der Desmidiaceen in Asien. Bih. till K. Sv. Vet.-Akad. Handl. xiii, Afd. III, no. 9, 1888.

Lagerh. *Contrib. alg. Ecuad.*—G. Lagerheim, Contribuciones a la Flora algologica del Ecuador. Anales de la Universidad de Quito. iv, 1890.

Lagerh. *Chlor. Abessin. u. Kordofan.*—G. Lagerheim, Chlorophyceen aus Abessinien und Kordofan. La Nuova Notarisia. ser. 4, 1893.

Lagerh. *Phycoporph.*—G. Lagerheim, Ueber das Phycoporphyrin, einer Conjugatenfarbstoff. Vidensk.-Sels. Skrift. I. math.-nat. kl. 1895.

Lemaire, *Liste Desm. Vosges.*—Ad. Lemaire, Liste des Desmidiées, observées dans les Vosges jusqu'en 1882 précedée d'une introduction contenant des indications sur la récolte et la préparation de ces Algues. Bull. Soc. d. Sciences Nancy. ser. 2, vi, 1883.

Lemm. *in Klebahn & Lemm. Vorarbeit. Flor. Plön. Seengebeits.*—Vorarbeiten zu einer Flora des Plöner Seengebeits. 2. Verzeichniss der in der Umgebend von Ploen gesammelten Algen. Förschungsb. Biol. Stat. Plön. Heft 3, 1895.

LEMM. *Algenfl. Riesengebirges.*—E. Lemmermann, Zur Algenflora des Riesengebirges. Forschungsberichte aus der Biol. Stat. zu Plön, Th. IV, 1896.

LEMM. *Beitrag Algenfl. Schles.*—E. Lemmermann, Beitrag zur Algenfl. von Schlesien. Abhand. d. Naturw. Ver. z. Bremen, xiv, Heft 2, 1897.

LEMM. *Beitr. Kenntniss Planktonalg.*—E. Lemmermann, Beiträge zur Kenntniss der Planktonalgen. Botan. Centralblatt. lxxvi, 1898.

LEMM. *Planktonalgen.*—E. Lemmermann, Planktonalgen; Ergebuisse einer Reise nach dem Pacific. Abh. Nat. Ver. Brem., xvi, Heft 2, 1899.

LEMM. *Phytoplankton sächsis. Teiche.*—E. Lemmermann, Das Phytoplankton sächsischer Teiche. Plöner Forschungsberichten, Teil 7, 1899.

LEMM. *Beitr. z. Kenntn. der Planktonalg.*—E. Lemmermann, Beiträge zur Kenntniss der Planktonalgen. Berichte der Deutsch. Botan. Gesellsch. xviii, 1900.

LEWIN, *Span. Süsswasseralg.*—M. Lewin, Ueber spanische Süsswasseralgen. Bih. till K. Sv. Vet.-Akad. Handl. xiv, Afd. III, no. 1, 1888.

LUND. *Desm. Suec.*—Lundell, De Desmidiaceis quæ in Suecia inventæ sunt observationes criticæ. Nova Acta reg. soc. scient. Upsala, ser. 3, viii, 1871.

LÜTKEM. *Desm. Attersees.*—Lütkemüller, Desmidiaceen aus der Umgebung des Attersees in Oberösterreich. Verhand. der k. k. zool.-bot. Gesellsch. Wien, 1892.

LÜTKEM. *Gatt. Spirotæn.*—Lütkemüller, Ueber die Gattung Spirotænia Bréb. Österreich. botan. Zeitschrift. 1895, nos. 1 and 2.

LÜTKEM. *Desm. Central China.*—J. Lütkemüller, Desmidiaceen aus den Ningpo-mountains in Centralchina. Ann. des. k. k. Naturhist. Hofmus. Wien. xv, Heft 2, 1900.

LÜTKEM. *Desm. Millstättersees.*—Lütkemüller, Desmidiaceen aus der Umgebung des Millstättersees in Kärnten. Verhandl. der k. k. zool.-botan. Gesellsch. Wien. l (50), 1900.

LÜTKEM. *Zellmembr. Desmid.*—Lütkemüller, Die Zellmembran der Desmidiaceen. Beiträge zur Biologie der Pflanzen, herausgegeben von Dr. Ferdinand Cohn, viii, 1902.

LÜTKEM. *Gatt. Spirotæn. II.*—J. Lütkemüller, Ueber die Gattung Spirotænia. II. Beschreibung neuer Arten und Bemerkungen über bekaunte. Oesterr. botan. Zeitschr. 1903, no. 10.

Marquand.—The Desmids and Diatoms of West Cornwall. Trans. Penzance Nat. Hist. and Antiq. Soc., i, 1882–3, and 1883–4.

Mask. *N. Zeal. Desm.*—W. M. Maskell, Contributions towards a list of the New Zealand Desmidieæ. Trans. N. Zeal. Institute, xiii, 1881.

Mask. *N. Zeal. Desm. Add.*—W. M. Maskell, On the New Zealand Desmidieæ. Additions to Catalogue and Notes on various Species. Trans. N. Zeal. Institute, xv, 1883.

Mask. *Note Micr. Americana.*—W. M. Maskell, Note on *Micrasterias Americana* Ralfs and its varieties. Journ. Roy. Micr. Soc. 1888.

Mask. *Further Notes N. Zeal. Desm.*—W. M. Maskell, Further Notes on the Desmidieæ of New Zealand, etc. Trans. N. Zeal. Instit. xxi, 1888 (1889).

Menegh. *Monogr. Nostoch.*—G. Meneghini, Monographia Nostochinearum italicarum addito specimine de Rivulariis, 1842. Accad. r. delle Sc. d. Torino. Class mat. e fis. 2 ser. v, 1843.

Menegh. *Synops. Desm.*—G. Meneghini, Synopsis Desmidiarum hucusque cognitarum. Linnæa, 1840, p. 201–240.

Möbius, *Austral. Süsswasseralg.* — M. Möbius, Australiche Süsswasseralgen. Flora, 1892, Heft 3.

Näg. *Gatt. einz. Alg.*—Nägeli, Gattungen einzelliger Algen physiologisch und systematisch bearbeitet. viii, Zurich, 1849.

Nitzsch, *Beitr. zur Infusor. oder Naturbeschr. der Zerkarien und Bazillarien.*—Neue Schriften der naturforschenden Gesellschaft zu Halle. Dritter Bd. Halle, 1817.

Nordst. *Desm. Brasil.*—O. Nordstedt, Part 5, 18 Fam. Desmidiaceæ, in E. Warming Symbolæ ad Floram Brasiliæ centralis cognoscendam. Vidensk. Medd. f. d. naturh. Foren. i Kjöbenhavn 1869, nos. 14–15 (1870).

Nordst. *Desm. Spetsb.*—O. Nordstedt, Desmidieæ ex insulis Spetsbergensibus et Beeren Eiland in expeditionibus annorum 1868 et 1870 suecanis collectæ. Öfvers. af K. Vet.-Akad. Förh. 1872, no. 6.

Nordst. *Norges Desm.*—O. Nordstedt, Bidrag till Kännedomen om sydligare Norges Desmidieer. Acta Univ. Lund. ix, 1873.

Nordst. *Desm. Arctoæ.*—O. Nordstedt, Desmidieæ arctoæ. Öfvers. af K. Vet.-Acad. Förh. 1875, no. 6.

Nordst. *Desm. Ital.*—O. Nordstedt, "Desmidieæ" in Nordstedt & Wittrock, Desmidieæ et Œdogonieæ in Italia et Tyrolia collectæ. Öfvers. af K. Vet.-Akad. Förh. 1876, no. 6.

Nordst. *Alg. Brasil.*—O. Nordstedt, Nonnullæ algæ aquæ dulcis brasiliensis. Öfvers. af K. Vet.-Akad. Förh. 1877, no. 3.

Nordst. *Alg. aq. dulc. et Char. Sandvic.*—O. Nordstedt, De Algis aquæ dulcis et de Characeis ex insulis Sandviscensibus a Sv. Berggren 1875 reportatis. Lund. 1878.

Nordst. *Alg. et Char. I.*—O. Nordstedt, De Algis et Characeis. I. De Algis nonnullis, præcipue Desmidieis, inter Utricularias Musei Lugduno-Batavi. Acta Univers. Lund. xvi, 1880.

Nordst. *Desm. Grönland.*—O. Nordstedt, Desmidieer samlade af S. Berggren under Nordenskiöldska expeditionen till Grönland 1870. Öfvers. af K. Vet.-Akad. Förh. 1885, no. 3.

Nordst. *in Journ. Bot.*—O. Nordstedt, The Figures in Cooke's "British Desmids." Journ. Bot. xxv, Dec. 1887.

Nordst. *in Botan. Notis.*—O. Nordstedt, Utdrag ur ett arbete öfver de af Dr. S. Berggren på Nya Seland och i Australien samlade sötvattensalgerna. Botaniska Notiser, 1887.

Nordst. *Bornh. Desm.*—O. Nordstedt, Desmidieer från Bornholm. Videnskab. Meddel. f. d. naturh. Foren. Kjöbenhavn. 1888.

Nordst. *Freshw. Alg. N. Zeal.*—O. Nordstedt, Fresh-water Algæ, collected by Dr. S. Berggren in New Zealand and Australia. Kongl. Sv. Vet.-Akad. Handl. xxii, no. 8, 1888.

Nordst. *in Hedwigia.*—O. Nordstedt, Die Behandlung einiger Süsswasseralgen, besonders der Desmidiaceen, in O. Kuntze's Revisio generum plantarum. Hedwigia, 1893, xxxii, Heft 3.

Nordst. *Index Desmid.*—O. Nordstedt, Index Desmidiacearum citationibus locupletissimus atque Bibliographia. Lund. 1896.

Ostenfeld, *Stud. Phytoplankton I.*—C. H. Ostenfeld, Studies on Phytoplankton I. Botanisk Tidsskrift xxv, Heft 2, 1903.

Perty, *Kleinst. Lebensf.*—M. Perty, Zur Kenntniss kleinster Lebensformen nau Bau, Funktionen, Systematik, mit Specialverzeichniss der in der Schweiz beobachtetenen. Bern, 1852.

Pieters, *Plants of Western Lake Erie.*—A. J. Pieters, The Plants of Western Lake Erie. Bull. U. S. Fish Commission, 1901.

Rabenh. *Alg.*—Rabenhorst, Die Algen Sachsens. (coll. exsicc.) Dresden, 1850–79.

Rabenh. *Krypt. Fl. Sachs.*—Rabenhorst, Kryptogamenflora von Sachsen, der Ober-Lausitz, Thuringen und Nordböhmen, mit Berüchsichtigung der Benachbarten Länder. Leipzig, 1863.

Rabenh. *Flor. Europ. Alg.*—Rabenhorst, Flora Europæa Algarum, aquæ dulcis et submarinæ. Lipsiæ, 1868, sect. iii.

Racib. *Nonn. Desm. Polon.*—M. Raciborski, De nonnullis Desmidiaceis novis vel minus cognitis, quæ in Polonia inventæ sunt. Pamiętnik Wydz. Akad. Umiej. w Krakow. x, 1885.

Racib. *Desm. Nowe.*—M. Raciborski, Desmidyje Nowe. Pamiętnik. Wydz. matem.-przy. Akad. Umiej. Krakow. xvii, 1889.

Racib. *Desmidyja Ciastonia.*—M. Raciborski, Desmidyja zebrane przez Dr. E. Ciastonia, w podrózy na okolo ziemi. Rospraw Wydz. matem.-przy. Akad. Umiej. Krakow. xxii, 1892.

Racib. *Desm. Tapakoomas.*—M. Raciborski, Die Desmidieenflora des Tapakoomasees. Flora, lxxxi, 1895.

Ralfs, *Brit. Desm.*—J. Ralfs, The British Desmidieæ. London, 1848.

Reinsch, *Spec. Gen. Alg.*—P. Reinsch, De speciebus generibusque nonnullis novis ex Algarum et Fungorum classe. Francofurti ad Moenum. 1867.

Reinsch, *Algenfl. Frank.*—P. Reinsch, Die Algenflora des mittleren Theiles von Franken. Abhandl. d. Naturhistor. Gesellsch. zu Nürnberg, iii, Heft 2, 1867 (1866).

Reinsch, *Contrib. Alg. et Fung.*—P. Reinsch, Contributiones ad Algalogiam et Fungalogiam. i, Lipsiæ, 1875.

Reinsch, *Alg. Ins. Kerguelen.*—P. Reinsch, Species ac Genera nova Algarum aquæ dulcis, quæ sunt inventa in Speciminibus in expeditione Vener. transit. hieme 1874–75 in Insula Kerguelensi a clar. Eaton collectis. Journ. Linn. Soc. bot. xv, 1876.

Reinsch, *Alg. Prom. Bon. Spei.*—P. Reinsch, Contributiones ad floram Algarum aquæ dulcis Promontorii Bonæ Spei. Journ. Linn. Soc. bot. xvi, 1877.

Richter, *in Hedwigia*.—P. Richter, Pleurotænium nobile nov. sp. Hedwigia, ix, 1865.

Roy, *Desm. Perthshire*.—J. Roy, Contributions to the Desmid Flora of Perthshire. Scottish Naturalist, April, 1877.

Roy *in Flora of Leicestershire*.—J. Roy, The Desmidieæ of the county of Leicester, in 'Flora of Leicestershire.' Leicester Lit. and Philosoph. Soc. London, 1886.

Roy, *Desm. Alford District*.—J. Roy, The Desmids of the Alford District. Scottish Naturalist, x, Jan. 1890.

Roy, *Freshw. Alg. Enbridge Lake and Vicin*.—J. Roy, Freshwater Algæ of Enbridge Lake and Vicinity, Hampshire. Journ. Bot. xxviii, Nov. 1890.

Roy & Biss. *Jap. Desm*.—J. Roy and J. P. Bissett, Notes on Japanese Desmids. Journ. Bot. xxv, July and Aug. 1886.

Roy & Biss. *Scott. Desm*.—J. Roy and J. P. Bissett, On Scottish Desmidieæ. Ann. Scott. Nat. Hist. 1893–94.

Schaarschm. *Magyar. Desm*.—J. Schaarschmidt, Tanulmányok a Magyarhoni Desmidiaceákról. Magyar. Tudom. Akad. Math. s. Természettud. Közlemények. xviii, 1882, Budapest.

Schaarschm. *Afghan. Alg*.—J. Schaarschmidt, Notes on Afghanistan Algæ. Journ. Linn. Soc. bot. xxi, 1884.

Schmidle, *Beitr. Algenfl. Schwarzwald. u. Rheineb*.—W. Schmidle, Beiträge zur Algenflora des Schwarzwaldes und der Rheinebene. Berichte der Naturforschenden Gesellschaft zu Freiburg i. B. vii, Heft 1, 1893.

Schmidle, *Alg. Geb. Oberrheins*.—W. Schmidle, Algen aus dem Gebiete des Oberrheins. Bericht. Deutsch. Botan. Gesellsch. xi, Heft 10, 1893.

Schmidle, *Variabil. Cosmar*.—W. Schmidle, Ueber die individuelle Variabilität einer Cosmarienspecies. Hedwigia, xxxii, Heft 3, 1893.

Schmidle, *Chloropհy.-Fl. Torfstiche Virnheim*.—W. Schmidle, Aus der Chlorophyceen-Flora der Torfstiche zu Virnheim. Flora order allg. Bot. Zeitung. 1894, Heft 1.

Schmidle, *Alg. Bern. Alp*.—W. Schmidle, Einzellige Algen aus den Berner Alpen. Hedwigia, xxxiii, 1894.

Schmidle, *Weit. Beitr. Algenfl. Rheineb. u. Schwarzwald*.—W. Schmidle, Weitere Beiträge zur Algenflora der Rheinebene und des Schwarzwaldes. Hedwigia, xxxiv, Heft 2, 1895.

SCHMIDLE, *Beitr. alp. Alg.*—W. Schmidle, Beiträge zur alpinen Algenflora. Österr. bot. Zeitschr. 45 Jahrg. 1895.

SCHMIDLE, *Alg. aus Sumatra.*—W. Schmidle, Einige Algen aus Sumatra. Hedwigia, xxxiv, 1895.

SCHMIDLE, *Süsswasseralg. Samoa.*—W. Schmidle, Süsswasseralgen in 'Die Flora der Samoa-Inseln.' Engler's Botan. Jahrbüch. xxiii, 1896.

SCHMIDLE, *Beitr. Algenfl. des Schwarzwald. u. Oberrheins VI.*—W. Schmidle, Beiträge zur Algenflora des Schwarzwaldes und des Oberrheins. Hedwigia, xxxvi, 1897.

SCHMIDLE, *Lappmark Süsswasseralgen.*—W. Schmidle, Ueber einige von Knut Bohlin in Pite Lappmark und Vesterbotten gesammelte Süsswasseralgen. Bihang till K. Sv. Vet.-Akad. Handl. xxiv, Afd. III, no. 8, 1898.

SCHMIDLE, *Ost-Afrika Desmid.*—W. Schmidle, Die von Professor Dr. Volkens und Dr. Stuhlmann in Ost-Afrika gesammelten Desmidiaceen. Engl. Botan. Jahrbüch. xxvi, 1898.

SCHMIDLE, *Ostind. Süsswasseralg.*—W. Schmidle, Ueber einige von Professor Hansgirg in Ostindien gesammelte Süsswasseralgen. Hedwigia, xxxix, 1900.

SCHMIDLE *in Simmer's Kryptogamenfl. der Kreuzeckgr. Kärnten.*—Hans Simmer, Vierter Bericht über die Kryptogamenflora der Kreuzeckgruppe in Kärnten. [Algæ by W. Schmidle.] Flor. Allgem. Botan. Zeitschrift, 1901.

SCHMIDLE, *Algen aus Brasil.*—W. Schmidle, Algen aus Brasilien. Hedwigia, xl, 1901.

SCHMIDLE, *Beitr. Algenfl. Afrik.*—W. Schmidle, Beiträge zur Algenflora Afrikas. Engler's Botan. Jahrbüch. xxx, 1901.

SCHMIDLE, *Algen Carolin.*—W. Schmidle, Einige Algen welche Prof. Volkens auf den Carolinen gesammelt hat. Hedwigia, xl, 1901.

SCHMIDLE, *Chloro- u. Cyanophyceenplankton Nyassa und anderer innerafrik. Seen.*—W. Schmidle, Das Chloro- und Cyanophyceenplankton des Nyassa und einiger anderer innerafrikanischer Seen. Engler's Botan. Jahrbüch. xxxiii, Heft 1, 1902.

SCHMIDLE, *Alg. aus Nyassa-See.*—W. Schmidle, Algen, insbesondere solche des Plankton, aus dem Nyassa-See und seiner Umgebung, gesammelt von Dr. Fülleborn. Botan. Ergebn. der Nyassa-See- und Kinga-Gebirgs-Expedition, in Engl. Botan. Jahrb. xxxii, 1903.

SCHMIDT, *Grundl. Algenfl. Lüneburg. Heide.*—M. Schmidt, Grundlagen einer Algenflora der Lüneburger Heide. Hildesheim, 1903.

SCHRÖDER, *Alg. Versuchsteiche Schles. Fischereiv. Trachenberg.*—B. Schröder, Die Algen der Versuchsteiche Schles. Fischereivereins zu Trachenberg. Forschungsberichten der Plöner biol. Station, Heft 5, 1897.

SCHRÖDER, *Beitr. Algen Riesengebirges.*—B. Schröder, Neue Beiträge zur Kenntnis der Algen des Riesengebirges. Forschungsberichten Biol. Stat. zu Plön. vi, 1898.

SCHRÖDER, *Planktonpfl. aus Seen von Westpreuss.*—Bruno Schröder, Planktonpflanzen aus Seen von Westpreussen. Berichte der Deutsch. Botan. Gesellsch. Bd. xvii, 1899.

SCHRÖDER, *Cosmocladium saxonicum De Bary.*—B. Schröder, Cosmocladium saxonicum De Bary. Bericht. der Deutsch. Botan. Gesellsch. xviii, Heft 1, 1900.

SCHRÖDER, *Gallertbildung Alg.*—B. Schröder, Untersuchungen über Gallertbildung der Algen. Verhandl. des Naturhist.-Med. Vereins zu Heidelberg. vii, Heft 2, 1902.

TURN. *Alg. Strensall Common.*—W. B. Turner, The Algæ of Strensall Common. Naturalist, viii, Dec. 1883.

TURN. *New and Rare Desm.*—W. B. Turner, On some new and rare Desmids. Journ. Roy. Micr. Soc. 1885.

TURN. *Notes Freshw. Alg.*—W. B. Turner, Notes on Freshwater Algæ with Descriptions of New Species. Naturalist, xii, Feb. 1886.

TURN. *in Trans. Leeds Nat Club.*—W. B. Turner, Algæ, in Contrib. to a Fauna et Flora of W. Yorks. Trans. Leeds Nat. Club, i, 1886.

TURN. *Freshw. Alg. E. India.*—W. B. Turner, The Freshwater Algæ (principally Desmidieæ) of East India. K. Svenska Vet.-Akad. Handl. xxv, no. 5, Stockholm (1892) 1893.

TURN. *Desm. Notes.*—W. B. Turner, Desmid Notes. Naturalist, xviii, Nov. 1893.

TURP. *Aperçu organograph.*—P. J. F. Turpin, Aperçu organographique sur le nombre deux. Mémoires du Mus. d'hist. nat. Paris, 1828.

WALLICH, *Desm. Low. Bengal.*—G. C. Wallich, Desmidiaceæ of lower Bengal. Ann. Mag. Nat. Hist. ser. 3, v, 1860.

TUFFEN WEST, *Rem. Diat. Desm.*—Tuffen West, Remarks on some Diatomaceæ new or imperfectly described and a new Desmid. Trans. Roy. Micr. Soc. viii, 1860.

WEST, *Desm. Maine.*—W. West, The Desmids of Maine. Journ. Bot. xxvi, Nov. 1888.

WEST, *Add. Alg. W. Yorks.*—W. West, Additions to the Algæ of West Yorkshire. Naturalist, xiv, March and April, 1889.

WEST, *Desm. Mass.*—W. West, List of Desmids from Massachusetts, U.S.A. Journ. Roy. Micr. Soc. 1889.

WEST, *Freshw. Alg. Maine.*—W. West, The Freshwater Algæ of Maine. Journ. Bot. xxvii, July, 1889.

WEST, *Alg. N. Yorks.*—W. West, The Freshwater Algæ of North Yorkshire. Journ. Bot. xxvii, Oct. 1889.

WEST, *Alg. N. Wales.*—W. West, A Contribution to the Freshwater Algæ of North Wales. Journ. Roy. Micr. Soc. June, 1890.

WEST, *Freshw. Alg. Maine II.*—W. West, The Freshwater Algæ of Maine. Journ. Bot. xxix, Dec. 1891.

WEST, *Add. Alg. W. Yorks. II.*—W. West, Additions to the Freshwater Algæ of West Yorkshire. Naturalist, xvi, Aug. 1891.

WEST, *Danish Algæ.*—W. West, Notes on Danish Algæ. La Nuova Notarisia. ser. 2, 1891.

WEST, *Alg. W. Ireland.*—W. West, A Contribution to the Freshwater Algæ of West Ireland. Journ. Linn. Soc. bot. xxix, 1892.

WEST, *Alg. aq. dulc. Lusitan.*—W. West, Nonnullæ algæ aquæ dulcis Lusitanicæ. La Notarisia, vii, 1892.

WEST, *Alg. Eng. Lake Distr.*—W. West, Algæ of the English Lake District. Journ. Roy. Micr. Soc. 1892.

WEST & G. S. WEST, *New Brit. Freshw. Alg.*—W. West and G. S. West, New British Freshwater Algæ. Journ. Roy. Micr. Soc. 1894.

WEST & G. S. WEST, *Alg. Madag.*—W. West and G. S. West, A Contribution to our Knowledge of the Freshwater Algæ of Madagascar. Trans. Linn. Soc. bot. ser. 2, v, part 2, 1895.

WEST & G. S. WEST, *Rec. publ. Desm.*—W. West and G. S. West, Some recently published Desmidieæ. Journ. Bot. xxxiii, March, 1895.

West & G. S. West, *New and Int. Freshw. Alg.*—W. West and G. S. West, On some New and Interesting Freshwater Algæ. Journ. Roy. Micr. Soc. 1896.

West & G. S. West, *Some N. Amer. Desm.*—W. West and G. S. West, On some North American Desmidieæ. Trans. Linn. Soc. bot. ser. 2, v, 1896.

West & G. S. West, *Welw. Afric. Freshw. Alg.*—W. West and G. S. West, Welwitsch's African Freshwater Algæ. Journ. Bot. xxxv, Jan.-Aug. 1897.

West & G. S. West, *Desm. Singapore.*—W. West and G. S. West, Desmids from Singapore. Journ. Linn. Soc. bot. xxxiii, 1897.

West & G. S. West, *Alg. S. England.*—W. West and G. S. West, A Contribution to the Freshwater Algæ of the South of England. Journ. Roy. Micr. Soc. 1897.

West & G. S. West, *Some Desm. U. S.*—W. West and G. S. West, On some Desmids of the United States. Journ. Linn. Soc. bot. xxxiii, 1898.

West & G. S. West, *Obs. on Conj.*—W. West and G. S. West, Observations on the Conjugatæ. Ann. Bot. xii, 1898.

West & G. S. West, *Notes Alg. I-III.*—W. West and G. S. West, Notes on Freshwater Algæ. I. Journ. Bot. xxxvi, Sept. 1898; II. Journ. Bot. xxxviii, Aug. 1900; III. Journ. Bot. xli, Febr. and March, 1903.

West & G. S. West, *Furth. Contrib. Freshw. Alg. W. Indies.*—W. West and G. S. West, A further Contribution to the Freshwater Algæ of the West Indies. Journ. Linn. Soc. bot. xxxiv, 1899.

West & G. S. West, *Freshw. Chlorophy. Koh Chang.*—W. West and G. S. West, in Johs. Schmidt's Flora of Koh Chang, Gulf of Siam, part iv. Botanisk Tidsskrift, xxiv, 1901.

West & G. S. West, *Alga-fl. Yorks.*—W. West and G. S. West, The Alga-flora of Yorkshire, a complete account of the known Freshwater Algæ of the county, with many notes on their affinities and distribution. Bot. Trans. Yorks. Nat. Union, v, 1901–2.

West & G. S. West, *Alg. N. Ireland.*—W. West and G. S. West, A Contribution to the Freshwater Algæ of the North of Ireland. Trans. Roy. Irish Acad. xxxii, section B, part 1, 1902.

West & G. S. West, *Freshw. Alg. Ceylon.*—W. West and G. S. West, A Contribution to the Freshwater Algæ of Ceylon. Trans. Linn. Soc. bot. ser. 2, vi, part 3, 1902.

WEST & G. S. WEST, *Scott. Freshw. Plankton, I.*—W. West and G. S. West, Scottish Freshwater Plankton.—No. 1. Journ. Linn. Soc. bot. xxxv, 1903.

G. S. WEST, *Alga-fl. Cambr.*—G. S. West, The Alga-flora of Cambridgeshire. Journ. Bot. xxxvii, Feb.—July, 1899.

G. S. WEST, *Variation Desm.*—G. S. West, On Variation in the Desmidieæ, and its Bearings on their Classification. Journ. Linn. Soc. bot. xxxiv, 1899.

G. S. WEST.—A Treatise on the British Freshwater Algæ. Cambridge (Univ. Press), 1904.

WILLE, *Ferskv. Alg. Nov. Semlj.*—Wille, Ferskvandsalger fra Novaja Semlja samlede af Dr. F. Kjellman paa Nordenskiölds Expedition 1875. Öfvers. K. Vet.-Akad. Förh. 1879, no. 5.

WILLE, *Norges Ferskv. Alg.*—Wille, Bidrag til Kundskaben om Norges Ferskvandsalger. Christiania Vidensk.-selsk. Forhandl. 1880, no. 11.

WILLE, *Sydamerik. Algfl.*—Wille, Bidrag til Sydamerikas Algflora. Bihang till K. Sv. Vet.-Akad. Handl. viii, no. 18, 1884.

WILLE, *in Naturl. Pflanzenfam.*—N. Wille, Desmidiaceæ in Engler & Prantl's Die naturlichen Pflanzenfamilien, I, 2, 1890.

WILLE, *Færöernes Ferskv. alg.*—N. Wille, Om Færöernes Ferskvandsalger og om Ferskvandsalgernes Spredningsmaader. Botan. Notiser. 1897.

WILLE, *Algolog. Notiz. VII.*—N. Wille, Algologische Notizen VII. Zur Verbreitung der Süsswasseralgen im südlichen Norwegen. Nyt Magazin f. Naturvidenskab. xxxix, Heft 1, 1901.

WILLS *in Midland Naturalist.*—A. W. Wills, List of Desmidieæ found in Sutton Park, Warwickshire. Midland Naturalist, iii, 1880.

WILLS *in Midland Naturalist.*—A. W. Wills, On the Desmidieæ of North Wales. Midland Naturalist, iv, 1881.

WITTR. *Skandinav. Desm.*—V. B. Wittrock, Anteckningar om Skandinaviens Desmidiaceer. Nova Acta Societ. Upsala, ser. 3, vii, 1869.

WITTR. *Gotl. Öl. sötv. Alg.*—V. B. Wittrock, Om Gotlands och Ölands sötvattensalger. Bih. till K. Vet.-Akad. Handl. i, no. 1, 1872.

WITTR. & NORDST. *Alg. Exsic.*—V. Wittrock and O. Nordstedt, Algæ aquæ dulcis exsiccatæ. Fasc. 21. Descript. system.

WITTR., NORDST., & LAGERH. *Alg. Exsic.*—V. Wittrock, O. Nordstedt, and G. Lagerheim, Algæ aquæ dulcis exsiccatæ. Fascic. 35. Descript. system.

WOLLE, *in Bull. Torr. Bot. Club,* 1882, pp. 25–30, t. 13.

WOLLE, *Desm. U. S.*—F. Wolle, Desmids of the United States and list of American Pediastrums. Bethlehem, Pa. 1884.

WOLLE, *Freshw. Alg. U. S.*—F. Wolle, Freshwater Algæ of the United States (exclusive of the Diatomaceæ), vols. i and ii. Bethlehem, Pa. 1887.

WOOD, *Freshw. Alg. N. Amer.*—H. C. Wood, A Contribution to the History of the Freshwater Algæ of N. America. Smithson. Contrib. Knowl. xix, no. 241, 1874.

BRITISH DESMIDIACEÆ.

vol. I

INTRODUCTION.

Desmids are unicellular plants of extremely varied form. Most of them are zygomorphically symmetrical in three different planes at right angles to each other. They are nearly always constricted in the middle, the constriction varying from a slight narrowing in the central portion of the cell to a relatively deep incision. The portion on each side of the constriction is termed a *semicell*, and that portion which connects the semicells is called the *isthmus*. The incision on each side of the isthmus between the semicells is known as the *sinus*, and the apices of the semicells are often termed the *poles*. In a few genera (such as *Closterium*, *Mesotænium*, *Gonatozygon*, and *Spirotænia*) in which the cell itself is not constricted, that part of the protoplasm which contains the chloroplasts is almost invariably divided into two symmetrical portions.

Before the time of Ralfs, who advocated the view that Desmids are unicellular, nearly every author with the exception of Kützing considered that they consisted of two cells, even Meneghini and Ehrenberg being under the impression that they were bicellular.

Desmids belong to the green Algæ (or Chlorophyceæ) of which by far the greater proportion are inhabitants of fresh water, and they constitute the family Desmidiaceæ of the order Conjugatæ. The Algæ are a class of plants which possess a simple structure, the most highly developed forms being the red Algæ (or Florideæ), which are almost entirely marine.

Although some Desmids possess cylindrical cells very similar to those of other families of Conjugatæ, they can be readily distinguished by peculiarities in their cell-structure, their method of division, and the formation of the zygospore.

Some few Algæ are subaërial, occurring in moist, shady places, and among these are a few Desmids, principally species of the genera *Mesotænium* and *Cylindrocystis*.

The Desmids are free-floating, and often occur in mucilaginous masses. They are never marine, but have been found, though rarely, in slightly brackish water. They exhibit great diversity in size, the longest axis varying in length from 8 to 1200 μ. In the British genera *Hyalotheca*, *Gymnozyga*, *Spondylosium*, *Sphærozosma*, *Onychonema*, and *Desmidium*, the cells remain attached to each other after division in the same manner as in the other families of Conjugatæ. These filaments may be plane or twisted, and the cells may be connected by their flat apices or by the apposition of corresponding apical projections. This filamentous condition may however be developed in species of genera which normally occur as single cells. Instances of this are known in *Cosmarium*, *Euastrum*, *Micrasterias*, and *Staurastrum*. The cells of the genera *Gonatozygon* and *Genicularia* frequently occur in long filaments, but a very slight disturbance is sufficient to cause the dissociation of these filaments into their separate cells. Even in the more typical filamentous forms such as *Desmidium*, *Hyalotheca*, *Sphærozosma*, and *Onychonema*, the filaments are usually dissociated into individual cells just prior to conjugation.

Every person who for the first time examines a varied collection of Desmids is astonished at their wonderful symmetry and their elegance of form. This feeling is highly intensified on observing the great variety of the forms, and astonishment increases when the beautiful ornamentation of some of them becomes manifest. Diatoms are admitted by all to be very beautiful microscopic objects, but they are far surpassed in elegance by Desmids.

The simplest forms are seen in the genera *Mesotænium*, *Cylindrocystis*, *Penium*, and *Spirotænia*, which consist of cylindrical or subcylindrical cells, usually without any constriction. Even in some of these the cell-wall is ornamented. In some species of *Penium* there is a distinct although slight median constriction, which is the first indication of the feature so characteristic of most Desmids, *viz.* the constriction of the cell into two semicells. In the large genus *Closterium*, and also in *Roya* and one or two other small genera, there is no constriction, but in those specified there is more elegance of form, many species of the former genus being most gracefully curved and gradually narrowed towards the extremities, whilst some of them have a slight ornamentation of the cell-wall. This is usually in the form of longitudinal striations. In *Docidium*, which is subcylindrical, there is always a division into two semicells with an ornamentation at the base of each, and some species possess a gracefully undulated outline. In *Pleurotænium* the apices are often ornamented. In *Tetmemorus* the apices are notched and the cell-wall is generally punctate. In most of the other genera of Desmids there is a more or less deep constriction, the semicells being connected by an isthmus of variable breadth. In *Cosmarium*, which is by far the largest genus of the family, many of the species exhibit an exquisite ornamentation of the cell-wall, being decorated with symmetrical patterns of granules, papillæ, or warts of various sizes and shapes. The next genus in point of view of numbers is *Staurastrum*, and in this genus is found the greatest diversity of form. In addition to granules and warts, many species of this genus are adorned with spines of variable length, or the angles of the semicells are produced into long hollow processes. Seen from the vertical view, many exhibit a radiating structure, the number of radii varying from three to ten. The two genera *Xanthidium* and *Euastrum* also contain some of the most beautifully ornamented Desmids, but perhaps the prettiest of all forms are to be found in the genus *Micrasterias*, the exquisite symmetry of the incised margins of species such as *Micrasterias apiculata*, *M. radiosa*, and *M. furcata*, being without parallel in the vegetable kingdom.

The great diversity of form and wonderfully varied character of Desmids are features associated with their almost exclusive confinement to small ponds or the quiet margins of lakes, localities suitable for their existence in large numbers. The complexity of outline, which is so frequently accompanied by a defensive armour of spines and spinous processes, has most probably been acquired as a means of resisting the attacks of aquatic animals, such as Amœbæ, Turbellaria, Oligochætes, Tardigrades, small aquatic larvæ of insects, and small species of Crustacea; and it is noteworthy that most species which occur on wet rocks and in other localities from which these enemies are almost entirely absent, possess as a rule a comparatively simple outline.

The **cell-wall** is composed of cellulose with a variable admixture of pectose. The pectose compounds are gelatinous, and in most Desmids they accumulate as a considerable mucilaginous mass on the outer surface of the cellulose wall. It is most probable that this accumulation is due to a gradual exudation of these gelatinous compounds through numerous minute pores present in the cellulose wall of almost all Desmids. This is largely borne out by the radiating fibrillar structure which is so characteristic of this mucus and which has at times caused serious errors of observation. The pectose compounds sometimes form a considerable proportion of the cell-wall, and by their gelatination cause an ecdysis of the outer layers of cellulose. The cell-wall is usually colourless, but sometimes is of a pale straw-colour or even of a reddish-brown tint. It is impregnated to a certain extent with lime, and an incineration of the living cells leaves an ash composed chiefly of calcium carbonate, a small quantity of calcium sulphate, and an insoluble residue which is probably silica.

The cell-wall is often beautifully sculptured or adorned with granules, warts, processes, spines, etc. In some species the wall is devoid of such embellishments, but the cell-walls of almost all Desmids if examined under a sufficiently high magnifying power exhibit fine punctulations which are the optical expression of the pores in the cellulose wall.

The **cell-protoplasm** occupies a large proportion of the interior of the wall, and a portion of it always completely lines the inner surface of the cell-wall. This protoplasm contains numerous granules, largely of a nutritive nature, and it exhibits a well-marked circulatory movement. This circulation of the protoplasm is very variable and irregular, and its movements are rendered easily visible owing to the contained protoplasmic granules. Vacuoles are present in the protoplasm, but their position and number largely depend on the form of the chromatophores and the general shape of the cell. There is usually a vacuole in the region of the isthmus between the two chloroplasts of constricted cells, but some genera, such as *Closterium* and *Pleurotænium*, invariably possess apical vacuoles. In these apical or terminal vacuoles many small crystals are usually found (sometimes only one), which exhibit a rapid vibratory or swarming movement. These minute crystals (often rhomboidal) are composed of calcium sulphate.

When Desmids are kept alive for some time, especially under abnormal conditions, the protoplasm develops numerous vacuoles, often of large size, all of which become filled with a dense swarming mass of granular material. This change has been observed to take place in all the genera.

The liquid contained in the vacuoles is known as *cell-sap* and is usually colourless. In certain species, such as *Mesotænium violascens* De Bary and *M. purpureum* West & G. S. West, the cell-sap is coloured violet or purple by a pigment which has been termed by Lagerheim *phycoporphyrin.*

The **chloroplasts** occur embedded in the protoplasm, either one or more in each cell. Sometimes they are parietal cushions or bands on the walls of the cells, but more frequently they are central. In *Spirotænia, Mesotænium, Roya,* and in some species of *Gonatozygon* and *Penium,* there is only one chloroplast. In those species with parietal chloroplasts there may be four, six, or eight, but the vast majority of Desmids possess two central chloroplasts, one in each semicell. The chloroplasts of the Desmidiaceæ are chiefly remarkable for their large size, their variability in different genera, and their peculiar complex character. They may be straight and rod-like, ridged and spirally twisted, or they may exhibit a radiating structure. In some of the larger Desmids, such as in certain species of *Euastrum* and *Micrasterias,* they are plate-like and their margins are incised or lobed corresponding to the incisions or lobes of the cell-wall. Embedded in each chloroplast are one or more large conspicuous pyrenoids (*Cosmarium, Staurastrum,* etc.), or in some cases numerous small pyrenoids (*Gonatozygon, Genicularia,* etc.). The pyrenoids are crystalloidal nitrogenous bodies, which usually become covered with minute starch-grains after exposure to light. They consist of reserve materials, and, with the exception of *Anthoceros* among the Hepaticæ, are quite peculiar to Algæ. The pyrenoids with their envelope of starch-grains are termed amylospheres.

There is one **nucleus** in each cell, generally situated in the central portion of the cell, and in those Desmids which are conspicuously constricted it is found in the region of the isthmus. It is globose or ellipsoidal in shape, and contains one nucleolus.

VARIATION.—Desmids are subject to certain variations of form and structure which have been summed up as follows:—

1. The structure of the cell-contents is one of the most constant features exhibited by the species; but this fact can be of little classificatory value owing to the very large number of species which possess the same structure and arrangement of the chromatophores.
2. The outward form of the cell, as seen in front view, varies within certain limits, which are usually very small, but which may in exceptional cases be considerable. The form of the vertical view is, as a rule, a more constant feature than the form of the front view.
3. The ornamentation (scrobiculations, granulations, spinulations, etc.) of the cell-wall is relatively constant, being always arranged according to a definite law, which is only transgressed by variations in one or more of the individual component groups which constitute the pattern of arrangement.
4. The prolific growth and rapid division of immense numbers of Desmids have a tendency to produce variations from the typical forms.
5. Changes in the conditions of environment cannot affect the characters of a species unless they act for a long period of time.

LOCOMOTION.—Desmids possess the power of slow locomotion. If numbers of them are placed in a small vessel and exposed to a moderate light they gradually travel to that side of the vessel nearest the light. Advantage may be taken of this fact, as we have often done, to obtain pure masses of Desmids from any muddy sediments in which they exist in quantity. Stahl, in making observations on the movements of *Closterium moniliferum*, noticed that the plant attached itself at one pole and then swung over and attached itself by the other pole, thus shifting its position by a distance equal to its own length. This is an exhibition of periodical polarity brought about by an alternation of positive and negative heliotropism or geotropism, or by a combination of both. Stahl's experiment was performed by placing the Desmids in glass tubes and altering the direction of the light by reflection. The longer axes of the cells placed themselves parallel to the incident rays, first one pole presenting itself towards the light and then the other. The reversal of position, which was a movement of the cell through an angle of 180°, occupied from six to thirty-five minutes according to the temperature; the change of position occurring more rapidly as the temperature increased, taking from six to eight minutes at a temperature of 33° C. In *Penium curtum* the polarity is constant, the young semicells always turning towards the light. Goebel found that *Micrasterias rotata* arranged itself so as to place its plate-like chloroplasts at right angles to the incident rays of light. Warming states that the movements are due to the protrusion of a mucilaginous stalk, and that they are partly dependent upon, and partly independent of heliotropism and geotropism.

The VEGETATIVE REPRODUCTION of Desmids takes place by the process of cell-division, but this presents a rather curious appearance, reminding one of gemmation, in those forms which possess a deep constriction. The first stage in this cell-division is an elongation of the isthmus causing the semicells to move slightly apart. The elongated isthmus increases in size, becomes somewhat swollen and turgid, and soon shows signs of a constriction. The constriction deepens, and when complete the two young semicells remain attached by their apices. The new semicells are at first much more delicate than the old ones, but they gradually increase in size until they ultimately attain the form and strength of the mature halves, when in most cases they soon separate. In those species which possess a sculptured cell-wall the new semicells are at first quite smooth, the markings only beginning to appear as the semicells approach maturity. In those species which have an incised outline the incisions begin to form long before the semicells have attained half their full size. Thus, in all Desmids one semicell is younger than the other. Division is most active in late spring or early summer according to the conditions of the climate.

ASEXUAL REPRODUCTION takes place by means of *aplanospores* in certain species of Desmids. Each aplanospore is formed by the rejuvenescence of the entire contents of a cell, a new cell-wall being developed round the spore. This method of reproduction is of exceedingly rare occurrence, having only been seen by Wallich and Turner in *Spondylosium nitens* and by ourselves in *Hyalotheca neglecta*. Ralfs most probably noticed spores of this nature in *Desmidium Swartzii*.

Archer's account of the occurrence of zoospores in a '*Docidium*' must have resulted from a mistaken observation, as all evidence tends to prove the entire absence of ciliated motile spores from the order Conjugatæ. It is most probable that some parasitic organism was present in the '*Docidium*,' which gave origin to the zoospores observed by him.

SEXUAL REPRODUCTION of an exceedingly degenerate type occurs in all the genera of Desmids. It takes place by the conjugation of isogamous gametes, *i.e.* by the union of precisely similar gametes. The ordinary vegetative cells themselves become the gametangia, and as the gametes possess no cilia they are known as aplanogametes.

Two cells of any one species having become approximated, they arrange themselves parallel to each other or inclined at various angles according to the genus to which they belong. From the middle of the contiguous sides, usually the sinus, a short connecting-tube is formed between the cells, arising by the coalescence of two processes, one from each cell. This connecting-tube may be conspicuous or exceedingly delicate, and in many Desmids is only represented by the delicate vesicle which surrounds the gametes. The gametes, each of which consists of the entire contents of a cell, issue into the connecting-tube (or into its representative vesicle) and there fuse together forming a *zygospore* (or *zygote*). This zygospore assumes a definite form, depending upon the species of Desmid, and then surrounds itself with a firm cell-wall, generally of a brown, sometimes of a black colour, and consisting of three layers. The zygospore may be spherical, ellipsoidal, or of any degree of angularity. It may be quite smooth, as in many species of *Closterium* and *Cosmarium;* it may be scrobiculate, as in *Xanthidium armatum;* or it may be furnished with simple spines, furcate spines, or branched processes, as in many species of *Cosmarium* and *Staurastrum.*

We have occasionally seen zygospores formed by the conjugation of three cells, and there is one record of a zygospore produced by the union of the contents of four cells. In *Mesotænium* the conjugating tubes may be put out from any part of the cell. *Desmidium cylindricum* stands alone amongst Desmids in having the zygospores produced in one of the conjugating cells, as in the case of *Spirogyra*, thus exhibiting a trace of sexual differentiation. Rarely the same phenomenon has been observed in *Hyalotheca dissiliens.* Lateral conjugation—or the conjugation of two adjacent cells in a Desmid filament—has been observed in *Spondylosium pulchrum* var. *planum.*

There is no doubt that conjugation frequently takes place between two individuals which have just separated by vegetative division, the two new semicells being as yet only imperfectly developed. This is frequently noticed in large species of the genus *Closterium*, such as *Cl. moniliferum* and *Cl. Ehrenbergii*, also in *Micrasterias denticulata* and in species of *Cos-*

marium and *Euastrum*. For there to be any lingering remains of sexuality under these circumstances, differentiation of sex could only occur immediately prior to conjugation.

The development of the zygospore has been worked out by De Bary, and there is no alternation of generations. He found that the gametes completely left the gametangia and united in from fifteen to forty minutes, but we have often known this process to take many hours. The time occupied in the escape and fusion of the gametes depends largely on the particular species under consideration. The development of the external ornamentation of a zygospore may take many days. When germination takes place the outer wall of the zygospore splits and the entire contents escape, surrounded by the colourless inner cell-wall. This escaped cell enlarges and soon becomes constricted, another constriction arising at right angles to the first one. Two or four new plants are thus formed which very soon appear of typical form and size. If the species bears external ornamentation, these first-formed cells are devoid of it, but on the first vegetative division the new semicells acquire the characteristic markings of the species. Hoffmeister, from observations on another species, states that the contents of the escaped cell divide repeatedly, forming eight or sixteen cells which have the same form, but not the same size as the parent cells, and that these cells then escape from the zygospore. Zygospores always rest some months before germination.

Double zygospores are found in some species, but little is known concerning their formation and nothing of their germination; they occur in *Closterium lineatum*, *Cl. Ralfsii* var. *hybridum*, *Cylindrocystis diplospora*, and *Penium didymocarpum*.

PHYLOGENETIC RELATIONSHIPS OF THE DESMIDIACEÆ.—The Desmidiaceæ must be regarded as a degenerate family of unicellular Algæ evolved by retrogression from sexually differentiated, filamentous Conjugates.

They constitute unquestionably the family of Conjugates which has attained a maximum state of specialization with regard to complexity of morphological characters, accompanied by the loss of the filamentous condition and the degeneration of sexual differences. It is a notable fact that *Desmidium cylindricum* is the only known Desmid in which the zygospore remains in one of the conjugating cells (presumably the female), and the occasional reversion to this type in *Hyalotheca dissiliens* goes far to prove that in all probability this was their ancestral type of conjugation,—a type which still exists in the Zygnemaceæ, but which the Desmidiaceæ have lost except for the lingering remains of it which are found in *Desmidium cylindricum*. Another fact testifying to this degeneration is the secondary assumption of the filamentous condition by about eight genera and several individual species of other genera. The recent discovery of that remarkable Conjugate *Debarya desmidioides* has also added still further evidence with regard to the evolution of Desmids from ancestral filamentous Conjugates.

Occurrence and Distribution.—Desmids occur from sea-level to just below the snow-line. A few species have been found in water that was somewhat brackish, but only in small numbers. Everything seems to indicate that they have but a precarious existence in such a medium; indeed, it is not only possible but probable that they have been introduced in such situations by aquatic birds. As they are usually free-floating plants they are not as a rule found in running waters. They are most abundant in permanent shallow pools and the quiet, sheltered recesses of small lakes. Some species can always be found in the hollows of peaty moors, whether natural or artificial, if of sufficient age. They are usually most abundant both with regard to number of species and individuals in the pools, tarns, and lakes of rocky districts. In flat districts like the fens they are few in number, especially in number of species, but in somewhat undulating, virgin, sandy districts they occur in considerable abundance. A few are met with among the submerged plants in slow streams and rivers, and some species usually occur on faces of rocks over which water is constantly trickling, growing associated with filamentous Algæ such as species of *Stigonema* and *Schizothrix*. Some occur in more rapidly running water among other Algæ, as *Vaucheria geminata* and *Sirogonium sticticum*; or among mosses such as *Blindia acuta*, *Fontinalis antipyretica*, *Amblystegium glaucum*, and *Rhacomitrium aciculare*; or among such Hepaticæ as *Scapania undulata*, *Aneura multifida*, and *Nardia emarginata*. The occurrence of some species where water is rapidly moving indicates that their mucilaginous investment possesses considerable tenacity. Some species are associated with *Batrachospermum vagum* in peaty waters, and in moor pools with *Jungermannia inflata*; others are attached to the leaves of *Isoëtes lacustris*, *Lobelia Dortmanna*, and *Eriocaulon*; the peduncles and petioles of *Nymphæa* and *Nuphar*; and the submerged parts of the stems and leaves of *Callitriche*, *Myriophyllum*, and *Scirpus fluitans*. *Utricularia minor* and *U. intermedia* are always submerged and are often clothed with a rich coat of Desmids. Many rare species occur on the leaves of the submerged form of *Littorella lacustris*, and a few on species of *Nitella* and *Chara* in the beds of rocky lakes. Desmids are also often associated with floating filamentous algæ of various genera. Many species occur in quiet pools among such mosses and Hepaticæ as *Sphagnum contortum*, *S. cuspidatum* var. *plumosum*, *Amblysteguim scorpioides*, and *A. exannulatum*; others occur in mountain springs where *Philonotis fontana*, *Jungermannia cordifolia*, *Saxifraga stellaris*, and *Epilobium alpinum* abound.

Some Desmids are found in the Plankton of large lakes, occurring in the surface-water far away from the shores. *Staurastrum anatinum*, *S. pelagicum*, *S. pseudo-*

pelagicum, *S. paradoxum* var. *longipes*, *S. jaculiferum*, and *Xanthidium antilopæum* are frequent plankton-Desmids.

A few are notably alpine or subalpine; such are *Staurastrum acarides*, *S. Kjellmanni*, *Cosmarium cymatopleurum*, *C. microsphinctum*, *C. cyclicum*, etc.

We have collected the following species at an elevation of 2,700 feet on Glyder Fawr, North Wales:—*Cylindrocystis crassa*, *Penium Digitus*, *P. polymorphum*, *Tetmemorus granulatus*, *T. Brébissonii*, *Closterium Ehrenbergii*, *Pleurotænium Trabecula*, *Euastrum binale*, *Cosmarium Cucurbita*, *C. Logiense*, *C. Ralfsii*, *Staurastrum Kjellmanni*, and *Hyalotheca dissiliens*.

We have also found the following in material collected for us by Mr. T. H. Burkhill at an elevation of 3,500 feet on Lochnagar:—*Cylindrocystis Brébissonii*, *Penium exiguum* forma *major*, *Tetmemorus lævis*, *T. granulatus*, *Euastrum binale*, *E. lobulatum*, *Micrasterias denticulata*, *Cosmarium latum* var. *minor*, *C. bioculatum*, *C. crenatum*, *Staurastrum erasum*, *S. Kjellmannii*, *S. muricatum*, *S. margaritaceum*, and *S. orbiculare* var. *depressum*.

At a still higher elevation, on some of the mountains of Perthshire, we have gathered a few species such as *Cosmarium cyclicum*.

Some of the most striking of British Desmids appear to be confined to the rocky districts of the west coast; such are *Pleurotænium nodosum*, *Docidium undulatum*, *Micrasterias furcata*, *Euastrum pingue*, *Staurastrum elongatum*, *S. longispinum*, *S. Arctiscon*, *S. Cerastes*, *S. Ophiura*, *S. verticillatum*, and *S. Brasiliense* var. *Lundellii*.

Some Desmids are absolutely cosmopolitan, occurring from sea-level to the snow-line; such are *Cylindrocystis Brébissonii*, *Tetmemorus granulatus*, and *T. lævis*. In fact, the latter species is known from hot springs in Iceland and the West Indies.

One of the chief determining factors of the abundance of Desmids in any locality is the nature of the geological formation of the district. Limestone and chalk districts yield few species, although one or two Desmids, such as *Cosmarium dovrense* and *Oocardium stratum*, have a preference for water saturated with calcium carbonate. Desmids are fairly numerous on some of the sandy undrained moors, but they only become generally abundant on the older Palæozoic Rocks, or on rocks of an igneous or metamorphic character.

COLLECTION AND PRESERVATION.—The collection of material requires very little apparatus. A number of corked glass tubes or wide-mouthed bottles of various sizes, from about half an inch to an inch and a half in diameter, will be found sufficient for most purposes. A few large wide-mouthed bottles will also be useful. All the bottles should bear numbered labels which have been varnished, and they should be wrapped separately in paper to prevent breakage. The numbers should be entered up consecutively in a pocket-book with spaces opposite each number for the description of the habitat and the locality. As each bottle is filled an entry should be made opposite its number in the pocket-book. The bottles should not be filled more than about two-thirds full, and they should be uncorked immediately on arrival home. For facility in moving the bottles about, they are best placed in small wooden boxes about an inch in depth, and packed so as to prevent upsetting. If it is desired to keep the material alive for some time it may be necessary to transfer the contents to larger bottles, as plenty of water is in most cases absolutely indispensable.

We have already mentioned the likely places in which Desmids occur, and now it remains to give a few hints on the collection of material. Desmids sometimes occur on submerged plants in such numbers that the brownish jelly in which they are embedded can be gently removed from the water by means of the fingers. This is, however, unusual, and submerged mosses, *Chara*, *Nitella*, *Callitriche*, *Myriophyllum*, or *Utricularia*, have generally to be lifted carefully out of the water, and after the superfluous liquid is allowed to drain away, squeezed over the wide mouth of the tube or bottle. The sediment that settles to the bottom of the bottle usually contains Desmids, more or less numerous. One may always depend upon finding *some* Desmids in material squeezed from permanently submerged *Sphagnum*.

Round the rigid leaves of *Isoëtes* and *Lobelia* there is often quite a thin gelatinous coating of a yellowish-brown colour. This can be removed from the water by getting the leaves between the fingers, with the hand palm upwards, and then gently drawing the hand upwards through the water. This method of collection requires much patience and some practice, as it is exceedingly difficult to raise in the open hand, light, flocculent, gelatinous material a distance of about two feet through the water. Most of the finest and purest material we have ever examined has been collected in this way.

All the larger Algæ should be carefully collected, because it is amongst these that some of the most interesting Desmids are found. Similarly, the home of many characteristic Desmids is amongst the mosses and filamentous Algæ which occur on dripping rocks.

In the sheltered corners of some lakes there is often a growth of *Phragmites* or *Scirpus lacustris*, and scrapings of the older stems of these plants frequently yield good results. A net of coarse muslin or a coarse copper strainer will be found to be very useful for passing amongst submerged plants. For the examination of large ponds and lakes the use of a boat is of great service and often indispensable.

To collect the plankton-material from large lakes, tow-nets are necessary. These nets are conical in shape and constructed of miller's silk; they are six or eight inches wide at the opening, and fourteen to twenty inches in length. The open end should be sewn on to coarse sail-cloth, the latter being doubled and fastened to a stout copper ring, and then three equidistant holes should be made through the sail-cloth close to the ring. Through these holes stout cords are passed, and the nets are towed at a distance of a few yards behind an ordinary rowing-boat. The speed of the boat should not be more than three or four miles an hour, and the net normally takes up a position a foot or eighteen inches below the surface of the water. The net should be towed for three-quarters of an hour or an hour at a time through the surface-waters of the deepest parts of the lake. It is then drawn in, the water is allowed to drain away, and the sediment is transferred to bottles.

Sometimes the material can be cleaned by a system of washing and decanting, that is to say, all the heavier material can be removed. Unless, however, the material is very dirty and sandy, we do not recommend cleaning it. If a person wishes to make a real study of Desmids he will do better to examine his collections just as they have been gathered; he will then become acquainted with the nature of the material among which they occur, and will soon obtain a good idea of what to expect in his collections.

Nice clean material may be obtained by placing the collections in flat dishes and exposing them to a fairly good light. The Desmids appear at the surface in small gelatinous masses and with care may be removed by means of a small dipping-tube. Another method is to decant off most of the water and cover the sediment with a piece of undyed sieving silk. If the silk is sufficiently coarse the Desmids will make their way through the meshes and can be removed. Such material always contains numerous living Diatoms.

Living material should always be examined as carefully as possible, and then it should be preserved for future examination.

There are several methods of preserving Desmids for subsequent examination. For examining the structure of the cell-contents a 3–4 per cent. solution of formalin is best, but for bringing out the cell-outline and the structure of the cell-wall we find nothing to equal a 4 per cent. solution of acetate of potassium (containing a trace of copper acetate). A solution of picric acid will also answer as a preservative, and a 0·1 per cent. solution of osmic acid may be utilised for fixing the cell-contents. Flemming's solution and also carbolic acid may be used as preservatives, but are not to be recommended.

When glass-stoppered bottles are not used, it is in all cases advisable to previously soak the corks in strong methylated spirit in order to destroy various spores of fungi.

EXAMINATION AND SPECIFIC DETERMINATION.—For the examination of Desmids a compound microscope is necessary with two powers of 70 to 100 and 400 to 600 diameters respectively, and it is sometimes essential to examine the smaller species under a magnification of 800 to 1000 diameters. In all cases *accurate* drawings should be made to scale with a camera lucida. We emphasize the word *accurate*, as great confusion has been—and still is—caused by the rough, inaccurate figures of Desmids which inexperienced authors have published. Desmids appear to be of very different forms according to the position in which they are seen, and for this reason it is necessary to have two or three views of most of them. They should be drawn in three positions:—(1) the *front view*, in which the two longest axes of the Desmid and the full constriction are seen; (2) the *side-view*, in which the longest and shortest axes and the constriction are seen; and (3) the *vertical view*, in which the Desmid is observed from above. With practice an observer can obtain these various positions with more or less ease.

Many species can only be accurately identified from empty cells or semicells in which the surface-markings can be plainly seen, and therefore preserved material is better for the identification of species than living material. If few empty cells can be found, treatment with a 5 per cent. alcoholic solution of potassium hydroxide is often very useful.

It is best to mount Desmids in the liquid in which they have been preserved, and old gold-size is the only safe varnish for sealing them up. The first coat of gold-size should be allowed to thoroughly dry before another one is put on. Sometimes an exceedingly thin, well-seasoned cell of gold-size is used in which to mount them. This cell must be prepared months beforehand by making a thin ring of gold-size on the slide. Nothing can equal these fluid mounts for purposes of future examination, but even the best of them frequently dry up. They may be mounted in glycerine jelly, and with great care the larger species can be placed in any desired position, but specimens mounted in this medium often exhibit considerable distortion.

The surest way of becoming acquainted with the diagnostic features of Desmids is to draw them very carefully in all positions. As previously stated these drawings should be made to scale by means of a camera lucida. This is also the best means of obtaining accurate measurements of the plants. The drawings can be finished off by direct observation, but the outline and the precise disposition and form of the markings must be drawn by means of the camera, in order to ensure exactitude. Needless to say some years of practice and experience are required before faithful representations of the smaller Desmids can be made. Strong fine drawing-paper should be used, and the only useful pencil is the "HHHH," sharpened on the finest emery paper. The drawings should be fixed on to stiff sheets of paper of uniform size, each sheet being devoted to one species. In this way the variations of a species can be best seen.

In conclusion, we must remark that this group of microscopic plants is well worth studying, and we sincerely hope that the appearance of our work will attract the attention of students to this beautiful and somewhat neglected family of plants. During a spring or a summer holiday, sufficient material can be collected to last many years. The Desmids offer a wide field for investigation, as many parts of the British Isles have not yet been examined. We have made many long journeys for years past specially for collecting these plants and other Algæ amongst which they are found, collecting daily through long holidays, but it is impossible for us unaided to cover the whole of the British Isles. We have been kindly helped in a few instances by material collected for us by friends in places which we have not ourselves visited. We have collected in Cumberland, Westmoreland, Durham, Yorkshire, Lancashire, Derbyshire, Lincolnshire, Cambridgeshire, Essex, Middlesex, Surrey, Sussex, Hampshire, Devonshire, Cornwall, the Scilly Isles; Anglesey, Carnarvonshire; Dumfriesshire, Kirkcudbrightshire, Wigtownshire, Ayrshire, Dumbartonshire, Perthshire, Argyllshire, Aberdeenshire, Inverness, Ross, Sutherland, Caithness, Isle of Skye, Lewis, Harris, North Uist, Benbecula, South Uist, the Orkney Isles, the Shetland Isles; Antrim, Londonderry, Donegal, Tyrone, Armagh, Down, Louth, Wicklow, Mayo, Galway, and Kerry. Archer also collected in Dublin, Wicklow, Galway, and Kerry, and was the pioneer in the investigation of the fresh-water Algæ of Ireland—especially of the Desmids. Roy collected from several Scottish counties and worked up material sent to him from other parts of Scotland. He also made some collections in Wales and examined a collection sent to him from Hampshire as well as material sent to him from Leicestershire. Ralfs did a good deal of work in West Cornwall and also collected at Dolgelly. Marquand added to the work done by Ralfs in West Cornwall. Jenner also collected good material in Sussex and Kent. This enumeration of counties shows clearly that a large part of the British Isles is yet unworked, and many of the counties enumerated have not been examined in a detailed manner. It is most desirable that much more work should be done in order to make our knowledge of the distribution of the Desmids more complete.

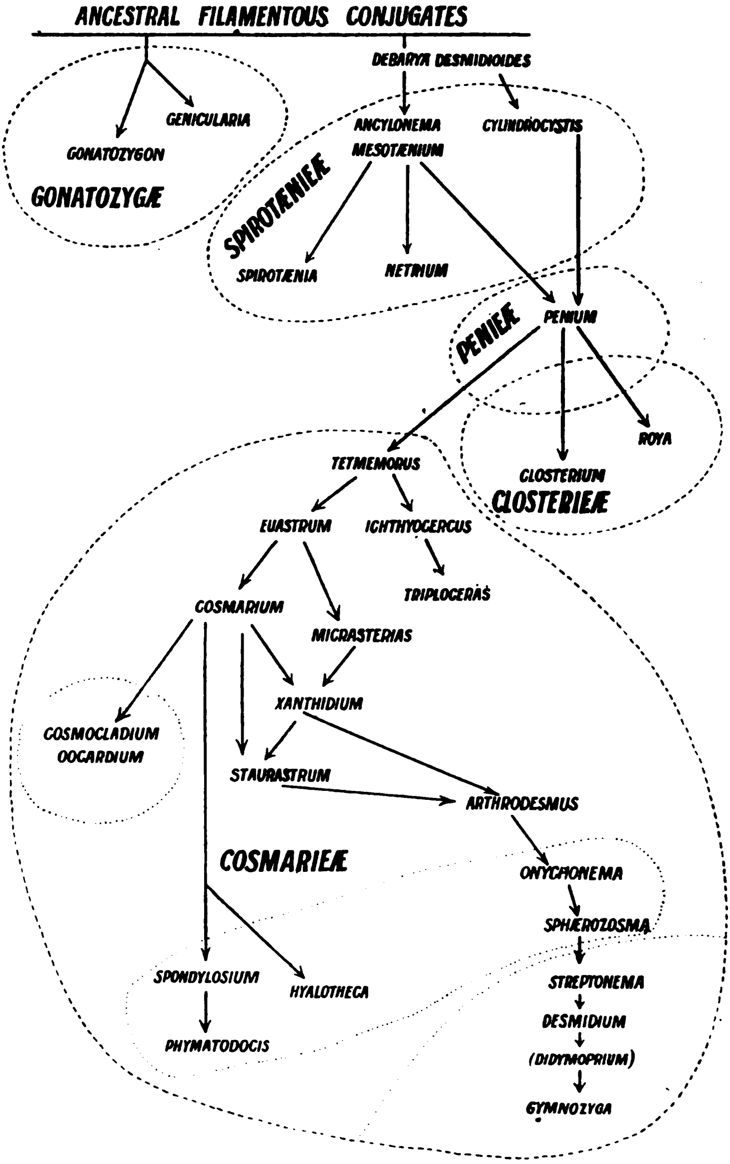
We would also impress upon future workers the desirability of examining any district they are studying at all periods of the year, and for more than one year; this applies more especially to those resident in or near such a district.

We have been very considerably helped in our investigation of the distribution of these plants in some of the remote districts by three grants from the Government Grant Committee of the Royal Society.

Dr. Otto Nordstedt of Lund, Sweden, has very kindly placed at our disposal the valuable Desmid material he collected when he visited Britain; this embraces many scores of gatherings. The material has been very useful, as such a noted and experienced algologist knew exactly how and where to collect. We believe that this work will show that considerably more is known concerning the Desmids of the British Isles than of those of any other country.

We have arranged the species of the larger genera in such a way as to facilitate their study.

The total number of Desmids known in the world in 1839 was about 90 species, in 1861 this had increased to about 300, in 1889 to about 1200, and in 1902 to about 2000. The number of species known to occur in the British Isles is approximately 690.



Phylogeny of the Genera of Desmids.

Order CONJUGATÆ.

This is one of the orders of the class Chlorophyceæ (or Green Algæ). The Algæ comprised in the order are characterised by their reproduction, which is a conjugation of isogamous gametes. This conjugation is a degenerate sexual reproduction, the gametes being alike in form and structure, and without cilia. Non-motile gametes of this nature are known as aplanogametes. The result of the conjugation is a *zygospore*, which, after resting for a shorter or longer period, produces on germination one or more new vegetative plants. Motile spores are entirely wanting in all plants of the order. Sometimes *aplanospores* (spores formed without conjugation) are produced. The cells may be solitary or united to form simple colonies or filaments, which usually float freely in the water. Division is in one direction only. All possess conspicuous green chromatophores (chloroplasts), and pyrenoids around which starch is formed. They are also remarkable for the great development of the gelatinous constituents of the cell-wall. They are found in fresh water, and very rarely indeed in slightly brackish water.

The two European families are :—

Fam. 1. Zygnemaceæ.
Fam. 2. Desmidiaceæ.

Family DESMIDIACEÆ.

Minute unicellular Conjugatæ, sometimes united into colonies of a more or less fragile nature. Cells very variable in form, usually constricted in the middle into two symmetrical halves or semicells. The cell-wall in the majority of Desmids exhibits characteristic surface-markings. Chloroplasts generally divided symmetrically, one in each semicell; sometimes two to six in each semicell, or only one in the entire cell.

The arrangement of the genera of Desmids given in this work is based upon the scheme of evolution already published by one of the authors, and upon certain recent investigations of Lütkemüller.

The division of Desmids into solitary forms and filamentous forms can no longer be followed. The genera *Gonatozygon* and *Genicularia*, although more specialised than *Spirotænia*, *Mesotænium*, or *Netrium*, have so little in common with most other Desmids that they must be regarded as having had a distinct origin from filamentous ancestors. Most of the genera of Desmids appear to have evolved from *Cylindrocystis* and *Mesotænium*, which were themselves derived from filamentous ancestors, through such Conjugates as *Debarya desmidioides*. The genus *Penium* undoubtedly contains a collection of widely different plants, some of which should be distributed in the Spirotænieæ, Closterieæ, and Cosmarieæ; and Lütkemüller's suggestion that Nägeli's genus *Netrium* be used to include certain well-marked forms is a most useful one. The *true Penia* are of the nature of *Penium margaritaceum*, *P. Cylindrus*, *P. spirostriolatum*, etc.

The genera *Docidium* and *Pleurotænium* belong unquestionably to the tribe Cosmarieæ, but their origin is doubtful.

The retention of the names *Pleurotæniopsis* and *Pleurenterium* as genera of Desmids is as useless as it is foolish. These were originally proposed as sub-genera by Lundell and afterwards elevated to the rank of genera by other less experienced authors. The establishment of such genera is against all principles of natural classification, as it necessitates placing in one genus a few of the most diverse forms of the present genera *Cosmarium* and *Staurastrum*,—forms which have obviously no direct relationship with each other. Similarly, the genus *Dysphinctium* Näg. (= *Calocylindrus* Kirchn.) has no definite line of demarcation from *Cosmarium* Corda.

The large genera *Cosmarium* and *Staurastrum* may at some future date have to be split up into smaller genera, but nothing could be more foolish than to do this without first obtaining a reasonable knowledge of the forms included in these genera. At present our knowledge is insufficient for such a purpose. And when the separation does take place, we do not think that either the relative depth of constriction or the position of the chloroplasts will be the basis upon which they will be subdivided. The arrangement of the chloroplasts is quite unknown in more than half of the species of these genera, and it is a character of such little importance that it has been customary to exclude it from specific descriptions of these Desmids.

The following is an analytical key to all the known genera of Desmids. Five of these, *viz.*—*Ancylonema*, *Triploceras*, *Ichthyocercus*, *Phymatodocis*, and *Streptonema*, have not been observed from the British Islands.

Sub-family I. SACCODERMÆ.

Cell-wall unsegmented, without pores. Point of division of cells not fixed, and unknown previous to the actual division. The young half of the cell is developed obliquely, and its walls are absolutely continuous with the walls of the older half.

Tribe 1. **Gonatozygæ.** Cells elongate, cylindrical and unconstricted, forming loose filaments. Cell-wall with a differentiated outer layer of which small roughnesses and spines form a part.

* Chloroplasts axile.
Gonatozygon.

** Chloroplasts parietal and spirally twisted.
Genicularia.

Tribe 2. **Spirotænieæ.** Cells solitary (except in *Ancylonema*), relatively short and mostly unconstricted. Cell-wall without a differentiated outer layer. There is a periodical growth of the cell until maturity is reached.

* One chloroplast in each cell.
† Chloroplast spirally twisted, axile or parietal.
Spirotænia.

†† Chloroplast plane, axile.
  ‡ Cells solitary.
      Mesotænium.
  ‡‡ Cells united into short filaments.
      Ancylonema.

** Two chloroplasts in each cell.
  † Chloroplasts star-shaped, radiating from a central pyrenoid.
      Cylindrocystis.
  †† Chloroplasts ridged with longitudinal ridges; edges of ridges notched.
      Netrium.

Sub-family II. PLACODERMÆ.

Cell-wall segmented, with a differentiated outer layer. Cell-division following a fixed type and the younger half-cells interpolated between the old ones. The younger portions of the cell-wall are not continuous with the older portions but are joined obliquely to them.

A. Point of division of cells variable or sometimes fixed (at the isthmus).

Tribe 3. **Penieæ.** Cells of moderate length, straight and more or less cylindrical, sometimes with a slight central constriction. Points of division often variable, following no law. Cell-wall with or without pores. There is frequently a periodical growth of the cell until maturity is reached.

Penium.

Tribe 4. **Closterieæ.** Cells elongate, generally curved. Points of division regularly placed in the middle region of the cell. Cell-wall commonly with pores.

* Cells almost cylindrical, scarcely attenuated. Chloroplast single. Nucleus in a lateral position. Apical vacuoles absent.
      Roya.

** Cells strongly attenuated towards each end. Two chloroplasts in each cell. Apical vacuoles with moving granules present.
      Closterium.

B. Point of division always fixed (at the isthmus).

Tribe 5. **Cosmarieæ.** The cells exhibit great diversity of form, and the cell-wall consists of two thin, firm layers with pores. The cell becomes adult soon after division by the mature growth of the young semicell. There is no periodical growth.

a. The obliquely-fitting new and old parts of the cell-wall at the point of division (the isthmus) remain plane. Solitary or colonial.

- * After division the cells become free and solitary individuals.
  - † Cells elongated and cylindrical; constriction slight.
    - ‡ Apices of cells truncate or rounded.
      - § Bases of semicells plicate. *Docidium.*
      - §§ Bases of semicells plane. *Pleurotænium.*
    - ‡‡ Apices of cells cleft, incision widely open or narrow.
      - § Cell-wall adorned with rings of furcate processes. *Triploceras.*
      - §§ Cell-wall plane.
        - || Apical incision widely open, apical angles furnished with a spine. *Ichthyocercus.*
        - |||| Apical incision narrow, apical angles rounded. *Tetmemorus.*
  - †† Cells relatively short, commonly compressed or radiating; constriction usually deep.
    - ‡ Cells compressed (at right angles to the plane of the front view); from the vertical view fusiform or elliptical.
      - § Cells almost always with an apical incision and a moderately lobed margin; with a central protuberance. *Euastrum.*
      - §§ Cells very compressed, with deeply lobed or incised margins. *Micrasterias.*
      - §§§ Cells with a more or less entire margin, often furnished with warts or spines.
        - || Cells commonly with a central protuberance.
          - ¶ Cell-wall either smooth, or granulate, or verrucose, etc. Central protuberance present or absent. *Cosmarium.*
          - ¶¶ Cell-wall with regularly arranged spines, generally in pairs. Central protuberance always present. *Xanthidium.*
        - |||| Cells without a central protuberance; angles spinate. *Arthrodesmus.*

‡‡ Cells from the vertical view commonly radiating; triangular, quadrangular, or up to 11-radiate; rarely fusiform.
Staurastrum.

** After division the cells remain attached to form colonies.
† Colonies spheroidal; cells not in contact, but joined together by gelatinous bands.
‡ Gelatinous bands narrow; few cells forming a microscopic colony.
Cosmocladium.
‡‡ Gelatinous bands very broad; many cells forming a macroscopic colony.
Oocardium.
†† Colonies thread-like; cells attached by their apices into long filaments.
‡ Cells attached by special apical processes.
§ Apical processes very short.
Sphærozosma.
§§ Apical processes long and overlapping the apex of the adjoining cell.
Onychonema.
‡‡ Apices of cells plane and flat.
§ Cells deeply constricted.
|| Cells in vertical view elliptical.
Spondylosium.
|| || Cells in vertical view quadrangular with produced angles.
Phymatodocis.
§§ Cells very slightly constricted.
Hyalotheca.

b. The obliquely-fitting new and old portions of the cell-wall at the point of division (the isthmus) develope a girdle-like thickening, which projects back into each of the old semicells during division. Cells attached to form thread-like colonies.

* Cells joined by special apical processes.
Streptonema.
** Cells joined by their flat apices or by flattened apical projections.
† Cells short; fusiform, triangular or quadrangular (rarely circular) in vertical view.
Desmidium.
†† Cells elongate, cylindrical.
Gymnozyga.

Sub-family I. SACCODERMÆ.

In this sub-family the cell-wall is unsegmented and entirely without pores. It is absolutely continuous, the newer half being indistinguishable from the older half. There is no fixed point at which division takes place (except in a few species of *Cylindrocystis*), and the young semicells are developed obliquely.

Tribe 1. Gonatozygæ.

The two genera included in this tribe are considerably removed from most other Desmids. The cells are long, more or less cylindrical, and are united by their apices to form very fragile filaments of variable length. A very slight disturbance will cause the filaments to dissociate into their individual cells, each of which then lives an independent existence. The cell-wall consists of two layers, the inner one being hyaline and structureless and the outer one being generally differentiated so as to give rise to the minute prominences and delicate spines which are characteristic of these plants. Conjugation only takes place between cells which have become free.

Genus 1. **GONATOZYGON** De Bary, 1856.

De Bary, in Hedwigia, 1856, p. 105; Conj. 1858, p. 26.
Cooke, Brit. Desm. 1886, p. 2.

Cells cylindrical or narrowly subfusiform, 10–20 (rarely 40) times longer than their diameter, not constricted, truncate, generally slightly dilated and often subcapitate at the apices; usually remaining attached to each other in filaments of variable length, which readily dissociate into the separate cells when disturbed, and always before conjugation; during conjugation sometimes geniculate. Chloroplasts two, or sometimes only one, axile, generally undulate and rather narrow, containing from four to sixteen equidistant pyrenoids.

Zygospore globose and smooth.

This genus, although widely distributed throughout the British Islands, is not really common, nor is it partial to any particular kind of district. The filaments, which are sometimes of great length, are exceedingly fragile, and a slight disturbance of the water is usually sufficient to cause them to break up into their individual cells, each of which then lives a free and independent existence. There are usually two chloroplasts in each cell, the small space between them in the centre of the cell being occupied by a certain amount of colourless protoplasm containing the nucleus. When only one chloroplast is present the nucleus is situated in the median portion of the cell in a lateral position. A terminal vacuole containing a group of minute moving granules is sometimes present at each end of the cell; this is best observed in *G. Kinahani.*

1. **Gonatozygon monotænium** De Bary.

(Pl. I, figs.1–7; Pl. V, fig. 5.)

Docidium? asperum **Ralfs, Brit. Desm. 1848, p. 158, t. xxi, f. 6 *a, b*.**
Gonatozygon monotænium De Bary, in **Rabenh. Alg. 1856, no. 539.**
G. Ralfsii **De Bary, Conj. 1858, p. 76, t. iv, f. 23–25; Archer, in Pritch. Infus. 1861, p. 721, t. iii, f. 1–2; Rabenh. Flor. Europ. Alg. 1868, III, p. 107; Cooke, Brit. Desm. 1886, p. 2, t. i, f. 1; Roy & Biss. Scott. Desm. 1894, p. 250; West and G. S. West, Alga-fl. Yorks. 1901, p. 39.**
Leptocystinema asperum Archer, Suppl. Cat. Desmid. 1858, v, p. 251, t. xxi, f. 5.
Gonatozygon asperum Rabenh. Krypt. Fl. Sachs. 1863, p. 181; Wolle, Desm. U.S. 1884, p. 22, t. i, f. 1.

Cells 10–25 times longer than their diameter, cylindrical, apices slightly dilated; cell-wall minutely and densely granulate; granules variable, sometimes very indistinct, sometimes strong and sharp, even papilliform. Pyrenoids about six to nine in each chloroplast.

Zygospore globose and smooth.

Length 82–284 μ; breadth 7·5–11·5 μ; breadth of apices 8·6–12·5 μ; diam. zygospore 25–28 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W., N., and E. Yorks! Zygospores from Cullingworth and Cautley Spout. Cheshire (*Roy*). Leicester (*Roy*). Cambridge! Surrey! Hants! (*Roy*). Devon! Cornwall! (*Marquand*).

WALES.—Capel Curig! (*Cooke and Wills*), Llyn Ogwen and Llyn Padarn, Carnarvonshire!

SCOTLAND.—Generally distributed! (*Roy & Bissett*). Skye in Inverness! Lewis and Harris, Outer Hebrides!

IRELAND.—Westport, Mayo! Baheh Loughs and near Recess, Galway! Muckross and Glengariff, Kerry! Dublin and Wicklow (*Archer*). Ram's Is., Lough Neagh! Loughs Anna, Darragh, and Gartan, Donegal! Lough Fea, Londonderry! Slieve Donard, Down! Tipperary, with zygospores (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Hungary. Sweden. Faeroes. N. Russia. Greenland. India. Ceylon. Siam. Sumatra. West, Central, and East Africa. W. Indies. United States. Brazil (var.).

Var. **pilosellum** Nordst.

Gonatozygon monotænium var. *pilosellum* Nordst. in Wittr. & Nordst. Alg. Exsic. 1886, no. 750; fasc. 21, p. 48.

Cell-wall furnished with fine papillate or spinate projections up to 2·5 μ in length.

WALES.—Between Llyniarth and Graig, near Dolgelly, Merioneth (*Nordstedt*).

IRELAND.—Dublin Mts. (*Archer*).

Geogr. Distribution.—Brazil.

This variety differs from *G. pilosum* Wolle in the slightly dilated apices of the cells and in the less acute hairs (or spines), which are also somewhat denser.

2. **Gonatozygon Brébissonii** De Bary.

(Plate I, figs. 8–11.)

Docidium? asperum Ralfs, Brit. Desm. 1848, t. xxi, f. 6*c*; Bréb. Liste Desm. 1856, p. 147, t. i, f. 33.

Gonatozygon Brébissonii De Bary, Conj. 1858, p. 77, t. iv, f. 26, 27; Archer, in Pritch. Infus. 1861, p. 722; Rabenh. Flor. Europ. Algar. III, 1868, p. 156; Cooke, Brit. Desm. 1886, p. 2, t. i, f. 2; West, Alg. W. Ireland, 1892, p. 114; Roy & Biss. Scot. Desm. 1894, p. 250.

Leptocystinema Portii Archer, Suppl. Cat. Desm. 1859, p. 251, t. xxi, f. 6.

Gonatozygon asperum Lutkem. Desm. Attersees, 1893, p. 539; Johnson, Rare Desm. N.S. II, 1895, p. 291, t. 239, f. 8.

Cells 10–16 (sometimes 30–40) times longer than their diameter, narrowly cylindrically-subfusiform, poles subcapitate; cell-wall minutely and densely granulate; granules variable, sometimes scarcely visible, sometimes strongly developed and very sharp. Pyrenoids five to sixteen in each chloroplast.

Zygospore globose and smooth.

Length 162–288 μ; breadth 6·8–10·8 μ; breadth of apices 5·8–10·3 μ; breadth just below apices 4·2–7·5 μ; diam. zygosp. 21 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W., N., and E. Yorks! Cheshire (*Roy*). Cambridge! Kent! Surrey! Hants! (*Roy*). Devon! Cornwall! (*Marquand*).

WALES.—Capel Curig (*Cooke and Wills*); near Dolbadarn Castle; Bethesda; Moelfre; Yr Orsedd, Carnarvonshire!

SCOTLAND.—General! (*Roy & Bissett*). Common in the Outer Hebrides! Shetlands!

IRELAND.—Generally distributed!

Geogr. Distribution.—France. Germany. Norway. Sweden. Faeroes. Italy. Austria. Poland. Greenland. Spitzbergen. India. W. Africa. United States.

This species is more generally distributed than *G. monotænium*, from which it is readily distinguished by the form of the cells. Although very long, the cells are somewhat fusiform and always attenuated towards the poles, which are subcapitate. In *G. monotænium* the cells are quite cylindrical and never attenuated towards the poles, which are slightly wider than any other portion of the cell.

Var. **læve** (Hilse) West & G. S. West. (Pl. I, figs. 12–14.)

Gonatozygon læve Hilse, in Rabenh. Alg. 1867, no. 1892; West, Alg. N. Yorks. p. 291, t. 291, f. 6 ("*G. læve* n. sp.").

Gonatozygon Brébissonii var. *læve* (Hilse) West and G. S. West, Alga-fl. Yorks. 1901, p. 39.

Cells 7–20 times longer than their diameter; cell-wall smooth.

Length 50–120 μ; breadth 4·5–8·7 μ; breadth of apices 4·3–5·5 μ.

ENGLAND.—Cocket Moss, near Giggleswick, and Penyghent, W. Yorks! Mickle Fell, N. Yorks! Epping Forest, Essex!

SCOTLAND.—Loch Harrow, Kirkcudbright!

IRELAND.—Clifden, Loughs Derryclare and Shannacloontippen, Galway! Lough Guitane and near Lough Brin, Kerry!

Geogr. Distribution.—Galicia in Austria. Germany.

This variety is more often found than the typical form at considerable elevations in mountainous districts. It has been placed as a distinct species, but all intermediate stages occur between the smooth forms and the roughest specimens of typical *G. Brébissonii.*

Var. **minutum** West & G. S. West. (Pl. I, figs. 15, 16.)

Gonatozygon minutum West, Alg. N. Wales, 1890, p. 282, t. v, f. 1; West, Alg. W. Ireland, 1892, p. 114.

G. Brébissonii var. *minutum* West & G. S. West, Alga-fl. Yorks. 1900, p. 39.

Cells much smaller than in the typical form, subcylindrical, and narrowed towards the poles; cell-wall minutely granulate.

Length 47·5–67·5 μ; breadth 4·2–7 μ.

ENGLAND.—Cumberland! Westmoreland! W. and E. Yorks! Surrey! Hants! Cornwall!

WALES.—Capel Curig and Llyn-y-cwm-ffynon, Carnarvonshire!

SCOTLAND.—Harris and Lewis, Outer Hebrides! Skye, Inverness!

IRELAND.—Frequent, especially in the west!

Geogr. Distribution.—East Africa.

3. **Gonatozygon Kjellmani** Wille.

(Plate I, fig. 17.)

Gonatozygon Kjellmani Wille, Ferskv. Alg. Nov. Semlj. 1897, p. 59, t. xiv, f. 78.

G. Brébissonii De Bary, var. *Kjellmani* Racib. Nonn. Desm. Polon. 1885, p. 69.

Cells 8 times longer than their diameter, commonly cylindrical, slightly curved, a little swollen in the middle, constricted under each pole; cell-wall very minutely punctulate. Pyrenoids about two in each chloroplast.

Zygospore unknown.

Length 72 μ; breadth 8 μ; breadth of apices 5–6 μ.

The typical plant has not been found in Britain; it is only known from Nova Zembla, Siberia, and Galicia in Austria.

Forma **minor** *nob.* (Pl. I, fig. 18.)

Gonatozygon Kjellmanii, forma West, Alg. Eng. Lake Distr. 1892, p. 718.

Cells rather smaller and straight.

Length 58 μ; breadth 6–6·5 μ.

ENGLAND.—Borrowdale, Cumberland!

This rare species has been placed by Raciborski as a variety of *G. Brébissonii,* but we think it possesses characters which easily distinguish it from that species. It is a much shorter species than *G. Brébissonii,* being relatively much wider, the apices are not so rounded, and the granulation is much finer.

4. **Gonatozygon pilosum** Wolle.

(Pl. I, figs. 19, 20.)

Gonatozygon pilosum Wolle, in Bull. Torr. Bot. Club, 1882, p 27, t. 13, f. 16; Desm. U.S. 1884, p. 32, t. i, f. 2; West, Alg. N. Wales, 1890, p. 282; West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 133.

Cells 12–20 times longer than their diameter, cylindrical; apices truncate, not at all or very slightly dilated; cell-wall more or less densely clothed with small, straight, hair-like spines. Pyrenoids about six in each chloroplast.

Zygospore unknown.

Length 177–300 μ; breadth (without spines) 10·5–15 μ; length of spines 2·5–5 μ.

ENGLAND.—Skipwith Common, E. Yorks!

WALES.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—India. Ceylon. Java. United States.

This is a rare species, resembling *G. monotænium* in the form of its cells, which are cylindrical and sometimes have slightly dilated apices. It is distinguished by the dense covering of fine, stiff spines.

5. **Gonatozygon Kinahani** (Arch.) Rabenh.

(Pl. II, figs. 1–3.)

Leptocystinema Kinahani Arch. Suppl. Cat. Desm. 1852, p. 243, 250, t. xxi, f. 1–4.

Gonatozygon Kinahani (Arch.) Rabenh. Flor. Europ. Alg. III, 1858, p. 156; Cooke, Brit. Desm. 1887, p. 3, t. 1, f. 3; West, Add. Alg. W. Yorks. II, 1891, p. 244; West, Alg. W. Ireland, 1892, p. 114; Roy & Biss. Scott. Desm. 1894, p. 250.

Cells 14–25 (sometimes 40) times longer than their diameter, cylindrical; apices truncate, sometimes very slightly dilated; cell-wall perfectly smooth. Pyrenoids four to ten in each chloroplast.

Zygospore unknown.

Length 162–376 μ; breadth 11–14 μ.

ENGLAND.—Malham Tarn and Penyghent, W. Yorks! Strensall Common, N. Yorks! Sheep's Green, Cambridge! Richmond Park and Wimbledon Common, Surrey!

SCOTLAND.—Scotston Moor, Whitestripes Moor, Tillyfour, Powlair, and Slewdrum, Aberdeen; Crathes, Kincardine (*Roy & Bissett*).

IRELAND.—Ballynahinch and lakes near Recess, Galway! Churchill, Donegal! Lough Fea, Londonderry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Italy. Siam (var.). United States.

This species is the only *Gonatozygon* with a perfectly smooth cell-wall. In form it is somewhat similar to *G. monotænium*, but is often of larger size. It is easily overlooked on account of its apparent resemblance to sterile filaments of certain species of *Mougeotia*. We have often obtained it in long filaments and sometimes in almost pure gatherings.

Genus 2. **GENICULARIA** De Bary, 1858.

De Bary, Conj. 1858, p. 77.
Cooke, Brit. Desm. 1887, p. 184.

Cells cylindrical, elongate, not constricted, apices truncate, remaining attached in filaments for some time, but separating previous to conjugation when they become geniculate. Chloroplasts two or three, forming parietal spiral bands, sometimes irregular. Cell-wall densely and minutely granulate.

Zygospores situated between the two conjugating cells.

1. **Genicularia spirotænia** De Bary.

(Pl. II, figs. 4–6; Pl. V, figs. 3, 4.)

Gonatozygon spirotænia De Bary, in Hedwigia, 1856, p. 106.
Genicularia spirotænia De Bary, Conj. 1858, p. 77, t. iv, f. 1–22; Arch. in Pritch. Infus. 1861, p. 721, t. iii, f. 3 (from De Bary); Rabenh. Flor. Europ. Algar. III, 1868, p. 156; Cooke, Brit. Desm. 1887, p. 184, t. 66, f. 6; West & G. S. West, Notes Alg. III, 1903, p. 8 (sep.).

Cells 10–20 times longer than their diameter, cylindrical; apices very slightly dilated. Pyrenoids fairly numerous in each chloroplast. Chloroplasts two or three, making from 4½–7½ turns.

Zygospore globose and smooth.

Length 200–400 μ; breadth 20–25 μ; breadth of apices 27–29 μ; diam. zygosp. 48–57 μ.

ENGLAND.—Hayle Pool, about four miles from the Lizard, Cornwall!

Geogr. Distribution.—Germany. Galicia in Austria.

This rare Desmid has been observed twice from Cornwall, but is not known from any other part of the British Islands. The genus *Genicularia* is one of the rarest of all known genera of Desmids.

2. **Genicularia elegans** West & G. S. West.

(Pl. V, figs. 1, 2.)

Genicularia elegans West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 536, t. 14, f. 1, 2.

Cells 20–28 times longer than their diameter, cylindrical and slightly curved; apices slightly dilated. Chloroplasts two, in very loose spirals making from 1½–4 turns. Pyrenoids very numerous.

Zygospore unknown.

Length 300–427 μ; breadth 14–16·3 μ; breadth of apices 17–18·5 μ.

SCOTLAND.—In the plankton of Loch nan Eun, N. Uist, Outer Hebrides !

We have only observed this interesting species in the plankton collections from the above-mentioned lake. It is distinguished from *G. spirotænia* De Bary by its narrower and more elongated cells, and by the fewer turns and laxer disposition of the two spiral chloroplasts.

Tribe 2. SPIROTÆNIEÆ.

In the genera of this tribe (with the one exception of *Ancylonema*, which is not a British genus) the cells are solitary, relatively short, and unconstricted (with the exception of a few species of *Cylindrocystis*). The cell-wall is not differentiated into two layers and is quite smooth. The individuals do not reach maturity by the mere growth of the younger half-cell, but there is a subsequent periodical growth, chiefly in length.

Genus 3. **SPIROTÆNIA** Bréb. 1848.

Bréb. in Ralfs' Brit. Desm. 1848, p. 178.
Arch. in Pritch. Infus. 1861, pp. 720 and 751.
Cooke, Brit. Desm. 1886, p. 50.
De Toni, Syll. Algar. 1889, p. 807.
Lütkem. Gatt. Spirotæn. 1895, p. 92.

Cells straight or almost straight, oblong-cylindrical or fusiform, not constricted, apices rounded, subacute, or acute; with a single chloroplast, band-like and parietal, or axile and cristate (or ridged), spirally twisted to the left; nucleus excentric; cell-wall smooth and colourless.

Species of this genus are never abundant and are mostly very uncommon. They are met with sparingly either amongst other Desmids in collections from bogs, or occasionally from wet rocks. They are easily overlooked owing to the delicate nature of the cell-wall and their generally inconspicuous appearance. There is frequently great difficulty in determining the precise nature of the chloroplast, and they often occur in pairs owing to the copious mucus holding the two individuals in the position they occupied immediately after division.

The genus is divided into two sections according to the axile or parietal disposition of the chloroplast.

Section 1. *Monotæniæ* Rabenh.; em. Lütkem.

Chloroplasts parietal, band-like; pyrenoids few and scattered.

1. **Spirotænia condensata** Bréb.

(Pl. II, figs. 7–10.)

Spirotænia condensata Bréb. in Ralfs' Brit. Desm. 1848, p. 179, t. 34, f. 1; De Bary, Conj. 1858, p. 75, t. 5, f. 12; Arch. Conj. Spirotæn. 1867, p. 186, t. 8, f. 5–11; Rabenh. Flor. Europ. Algar. III, 1868, p. 146; Wolle, Desm. U.S. 1884, p. 33, t. 8, f. 21, 22; Cooke, Brit. Desm. 1886, p. 50, t. 19, f. 3; West, Alg. W. Ireland, 1892, p. 133; Lütkem. Gatt. Spirotæn. 1895, p. 53; Nordst. Index Desmid. 1896, p. 78; West & G. S. West, Alg. S. England, 1897, p. 478; West & G. S. West, Alga-fl. Yorks. 1900, p. 39.

Cells large, cylindrical, 5–10 times longer than their diameter, poles rounded; chloroplast broad, parietal, with 7–12 rather close revolutions.

Zygospore globose; inner wall pale brown; outer wall colourless, thick, and furnished with large areolar markings.

Length 150–270 μ; breadth 18–27 μ; diam. zygosp. 60 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W. and N. Yorks! Lancashire! Leicester (*Roy*). Warwick (*Wills*). Norfolk (*Cooke*). Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Kent (*Ralfs*). Hants! (*Bennett*). Devon! Cornwall! (*Ralfs*).

WALES.—General in the mountainous districts!

SCOTLAND.—General!; occasionally with zygospores (*Roy & Bissett*). General in the Outer Hebrides!

IRELAND.—Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Down!

Geogr. Distribution.—France. Germany. Austria Italy. Norway. Sweden. Denmark. Russia. Poland

Nova Zembla. Spitzbergen. Japan. United States. Cuba.

This is the largest and most frequent of the British species of *Spirotænia.* It occurs frequently in bogs, especially in mountainous districts, and is a very striking Desmid. The cells may be quite straight or slightly but variously curved.

2. **Spirotænia closteridia** (Bréb.) Arch.

(Pl. II, fig. 19.)

Endospira closteridia Bréb. in Kütz. Tab. Phycolog. 1847, I, p. 24, t. 36, f. 2.
Palmoglœa closteridia Kütz. Spec. Alg. 1849, p. 228.
Spirotænia closteridia (Bréb.) Arch. in Proc. Dubl. Nat. Hist. Soc. 1864, p. 16; Rabenh. Flor. Europ. Alg. III, 1868, p. 146, fig. xylogr. p. 104; Roy & Biss. Scott. Desm. 1894; Nordst, Index Desmid. 1896, p. 75; Lütkem. Gatt. Spirotæn. II, 1903, p. 12 (sep.), t. 11, f. 12, 13.

Cells minute, 4–6½ times longer than their diameter, fusiform, usually distinctly curved, apices obtuse; chloroplast parietal, with two revolutions. Cells often gregarious in a mucilaginous jelly.

Zygospore unknown.

Length 14–28 μ; breadth 3·3–5 μ.

SCOTLAND.—Muchalls, Kincardine (*Roy & Bissett*).

Geogr. Distribution. — France. Germany (var.). Bohemia (var.).

3. **Spirotænia endospira** (Kütz.) Arch.

(Pl. II, figs. 20–23.)

Palmoglœa endospira Kütz. Tab. Phycolog. I, 1847, p. 19, t. 24, f. 6.
Endospira Bryophila Bréb. in Desmaz. Crypt. de Fr. 1850, fasc. 40, no. 1654.
Spirotænia muscicola De Bary, Conj. 1858, p. 75, t. 7 F; Arch. in Pritch. Infus. 1861, p. 751.
Spirotænia endospira (Kütz.) Arch. in Proc. Dubl. Nat. Hist. Soc. 1864, p. 15; Lütkem. Gatt. Spirotæn. II, 1903, p. 10 (sep.), t. 11, f. 10.
Spirotænia Bryophila (Bréb.) Rabenh. Flor. Europ. Alg. III, 1868, p. 146, fig. xylogr. p. 104; Wolle, Desm. U.S. 1884, p. 33, t. 3, f. 20; Cooke, Brit. Desm. 1886, p. 52, t. 19, f. 8; Nordst. Index Desmid. 1896, p. 70.

Cells small, 2 or 3 times longer than their diameter, oblong-cylindrical, straight or very slightly curved, apices rounded; chloroplast parietal, broad, with 1–1½ revolutions. Cells gregarious in a mucilaginous jelly.

Zygospore unknown.

Length 12–21 μ; breadth 6–7·4 μ.

ENGLAND.—Shipley Glen, W. Yorks!

WALES.—Capel Curig (*Roy*).

SCOTLAND.—Braes of Gight, Scotston Moor, Dalbagie, Aberdeen; Muchalls, Kincardine (*Roy & Bissett*).

IRELAND.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Switzerland. Hungary. Sweden. Faeroes. United States.

This is distinguished from the preceding species by its larger size and cylindrical cells. The chloroplast is also relatively broader.

4. **Spirotænia truncata** Arch.

(Pl. II, figs. 24–26.)

Spirotænia truncata Arch. in Proc. Dubl. Nat. Hist. Soc. 1862, p. 83, t. 2, f. 28–31; in Micr. Journ. 1862, p. 253, t. 12; Conj. Spirotæn. 1867, p. 191, t. 8, f. 12; Rabenh. Flor. Europ. Algar. III, 1868, p. 147; Cooke, Brit. Desm. 1886, p. 51, t. 19, f. 4; Nordst. Index Desmid. 1896, p. 261.

Cells small, cylindrical, 5–8 times longer than their diameter, attenuated near the apices which are truncate; chloroplast with two to six rather close revolutions leaving a minute clear space at the poles; this clear space or apical vacuole sometimes contains one or more moving granules.

Zygospore globose, closely covered with large, acutely-conical teeth.

Length 50 μ; breadth 7 μ; diam. zygospore without spines 18 μ, with spines 30–35 μ.

ENGLAND.—Angle Tarn, Cumberland!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Inverness (Skye), Aberdeen, Kincardine, Forfar, Perth, Argyle (*Roy & Bissett*).

IRELAND.—Dublin and Wicklow (*Archer*). Mourne Mts., Down! Zygospores from Glencar, Kerry, and from Westmeath (*Archer*).

Geogr. Distribution.—Denmark. Sweden. Nova Zembla. India (var.).

5. **Spirotænia minuta** Thur.

(Pl. III, figs. 1–3.)

Spirotænia minuta Thur. in Bréb. Liste Desm. 1856, pp. 157 and 303, t. 1, f. 30; De Bary, Conj. 1858, p. 75; Rabenh. Flor. Europ. Algar. III, 1868, p. 147; Kirchn. Alg. Schles. 1878, p. 136; Cooke, Brit. Desm. 1886, p. 51, t. 19, f. 7; Lütkem Gatt. Spirotæn. 1895, p. 54, t. 1, f. 21; Nordst. Index Desmid. 1896, p. 171.

Spirotænia erythrocephala Arch. in Pritch. Infus. 1861, p. 751 (*non* Itzigs.).

Cells small, 5–6 times longer than their diameter, fusiform, apices subacute or acutely rounded; chloroplast parietal, rather narrow, with three to five revolutions.

Zygospore unknown.

Length 15–40 μ; breadth 3–7 μ.

ENGLAND.—Pilmoor, N. Yorks! Enbridge Lake, Hants (*Roy*). Cornwall (*Marquand*).

WALES.—Llyn Idwal and Llyn Bochlwyd, Carnarvonshire!

SCOTLAND.—General (*Roy & Bissett*).

IRELAND.—Carrick Mountain, Wicklow (*Archer*). West of Glenties, Donegal! Slieve Donard, Down!

Geogr. Distribution.—France. Germany. Austria. Sweden.

Lütkemüller has recently placed the British forms of this species as "var. *obtusa*."

Var. **minutissima** Kirchn.

Spirotænia minuta Thur. var. *minutissima* Kirchn. Alg. Schles. 1878, p. 136; Roy & Biss. Scott. Desm. 1894, p. 250; Nordst. Index Desmid. 1896, p. 171.

About half the size of the typical plant and with the apices more acute; chloroplast broader.

Length 15–20 μ; breadth 3·5–4 μ.

SCOTLAND.—Strathpeffer, Ross; Glen Cattie, between Loch Kinnord and Cambus O'May, Aberdeen; Scolty, Kincardine; Fendoch Hill, Perth (*Roy & Bissett*).

Geogr. Distribution.—Germany.

Roy remarks that this variety forms "lines of from 20 to 30 individuals, in pairs, with a little distance between each pair, enveloped in mucus."

The variety has been elevated by Lütkemüller to a species under the name of "*Sp. Kirchneri*."

6. **Spirotænia eboracensis** G. S. West.

(Pl. III, figs. 4–6.)

Spirotænia minuta Thur. var. *eboracensis* West & G. S. West, Notes Alg. I, 1898, p. 2 (sep.); West & G. S. West, Alga-fl. Yorks. 1900, p. 40.
Spirotænia eboracensis G. S. West in Lütkem. Gatt. Spirotæn. II, 1903, p. 9 (sep.), t. 11, f. 7.

Cells small, about 4 times longer than their diameter, fusiform-elliptic, with rounded apices; chloroplast parietal, rather narrow, with 4–4½ revolutions.

Zygospore unknown.

Length 30–32 μ; breadth 7–8 μ.

ENGLAND.—Cam Fell, W. Yorkshire!

Not uncommon among *Cylindrocystis crassa*, *Netrium Digitus*, *Hyalotheca dissiliens*, etc., in peat bogs.

We agree with the recent suggestion of Lütkemüller that this plant should be regarded as a species distinct from *Spirotænia minuta*. It is distinguished by its relative shortness in proportion to its breadth, and by the outward form of the cell.

7. **Spirotænia turfosa** West & G. S. West.

(Pl. II, fig. 11.)

Spirotænia turfosa West & G. S. West, Notes Alg. I, 1898, p. 2 (sep.); Alga-fl. Yorks. 1900, p. 40.

Cells of medium size, about 12 times longer than their diameter, subcylindrical, elongate, almost straight or slightly curved, at each pole gradually attenuated, apices rounded; chloroplast parietal, rather broad, making only 1½–2 revolutions, pyrenoids small and scattered.

Zygospore unknown.

Length 100–102 μ; breadth 7·5–8·5 μ; breadth of apices about 4 μ.

ENGLAND.—Ilkley, W. Yorkshire!

This species, which was found in peaty pools, appears to come nearest to *S. parvula* Arch., but is of much larger size, is proportionately longer, and has more rounded and relatively wider ends. It differs from *S. fusiformis* in its larger size, its more rounded poles, and in having more turns of the chloroplast.

8. **Spirotænia fusiformis** West & G. S. West.

(Pl. II, figs. 12–14.)

Spirotænia fusiformis West & G. S. West, Notes Alg. I, 1898, p. 2 (sep.); Alga-fl. Yorks. 1900, p. 40.

Cells small, 10–12 times longer than their diameter, elongate, straight or often slightly oblique, cylindrico-fusiform, attenuated towards the apices which are acute but rounded; chloroplast parietal, rather broad and somewhat irregularly disposed from pole to pole, making ½ – ¾ of a revolution.

Zygospore unknown.

Length 42–58 μ; breadth 4·3–4·6 μ.

ENGLAND.—Cowgill Wold Moss, Widdale Fell, W. Yorkshire!

This species was found in peaty pools amongst *Sphagnum*. The cells were solitary or in pairs (after division) and occurred somewhat sparingly among a large quantity of *Arthrodesmus Incus*. It was very difficult to determine the precise nature of the chloroplast, on account of its indefiniteness and the small size of the plant; it only made from half to three-quarters of a turn, and the protoplasm (outside the chloroplast) contained some large granules.

It is distinguished from *S. tenerrima* Arch. by its greater diameter, its comparatively shorter cells, and by the different nature of the chloroplast.

9. **Spirotænia parvula** Arch.

(Pl. II, figs. 15–18.)

Spirotænia parvula Arch. Descript. new Cosm. etc. p. 84, t. 2, f. 32–43; Rabenh. Flor. Europ. Algar. III, 1868, p. 147; Lund. Desm. Suec. 1871, p. 91; Cooke, Brit. Desm. 1886, p. 51, t. 19, f. 5; Lütkem. Desm. Attersees, 1893, p. 540; Lütkem. Gatt. Spirotæn. 1895, p. 54; Nordst. Index Desm. 1896, p. 196.

Cells minute, 5–8 times longer than their diameter, slender, fusiform, apices gently rounded; chloroplast parietal, very narrow, making 1–1¼ revolutions.

Zygospore unknown.

Length 17–35 μ; breadth 3·5–4·5 μ.

ENGLAND.—Bowness, Westmoreland (*Bissett*). Enbridge Lake, Hants (*Roy*). Cornwall (*Marquand*).

WALES.—Glyder Fach, Carnarvonshire (at 2,200 ft.)!

SCOTLAND.—Nairn, Aberdeen, Kincardine, Forfar, Perth (*Roy & Bissett*). Rhiconich, Sutherland!

IRELAND.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Austria. Sweden. Brazil.

This species is sufficiently distinct by reason of the form of the cells and the narrow chloroplast with few turns. We are indebted to Dr. J. Lütkemüller for accurate figures of this plant.

Section 2. *Polytæniæ* Rabenh.

Chloroplast axile, cristate, with several spirally arranged ridges revolving to the left, rarely almost straight; with one axile series of pyrenoids.

10. **Spirotænia obscura** Ralfs.

(Pl. III, figs. 7–12.)

Spirotænia obscura Ralfs, Brit. Desm. 1848, p. 179, t. 34, f. 2; De Bary, Conj. 1858, p. 75; Arch. in Pritch. Infus. 1861, p. 752; Rabenh. Flor. Europ. Alg. III, 1868, p. 147; Wolle, Desm. U.S. 1884, p. 33, t. 3, f. 16–19; Cooke, Brit. Desm. 1886, p. 52, t. 19, f. 6; Lütkem. Gatt. Spirotæn. 1895, p. 2, 93, t. 1, f. 1–6, 15–19; Nordst. Index Desmid. 1896, p. 186; Roy. & Biss. Scott. Desm. 1894, p. 58 (sep.); West & G. S. West, Alg. S. England, 1897, p. 478.

Cells of medium size, 3½–8 times longer than their diameter, cylindrical or fusiform, attenuated towards each pole, apices rounded; chloroplast axile, not quite reaching the poles, cristate, with 3–8 ridges spirally twisted to the left, rarely almost straight, ridges thickened at the free margin; pyrenoids several.

Zygospore globose, areolate.

Length 50–210 μ; breadth 15–30 μ.

ENGLAND.—Westmoreland (*Bissett*). N. Yorks! Lancashire! Warwick (*Wills*). Kent (*Ralfs*). Surrey! Hants (*Roy*). Cornwall (*Ralfs*).

WALES.—Capel Curig! (*Cooke & Wills*); Llyn Idwal!; Y Foel Fras, Carnarvonshire!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Perth, Stirling; zygospores from Cammie, Kincardine (*Roy & Bissett*). Sutherland!

IRELAND.—Dublin and Wicklow (*Archer*). Near Loch Brin, Galway!

Geogr. Distribution.—France. Germany. Switzerland. Austria. Hungary. Italy. Norway. Sweden. Holland. Spitzbergen. Nova Zembla. United States.

11. **Spirotænia bispiralis** West.

(Pl. III, fig. 13.)

Spirotænia bispiralis West, Alg. W. Ireland, 1892, p. 133, t. 20, f. 8; Lütkem. Gatt. Spirotæn. 1895, p. 57; Nordst. Index Desmid. 1896, p. 62.

Cells large, 5 times longer than their diameter, fusiform, poles subtruncate; chloroplast axile, with two narrow ridges arranged in close spirals making about 9 revolutions.

Zygospore unknown.

Length 86–100 μ; breadth 18–20 μ; breadth just below apices 4–6 μ.

IRELAND.—Near Westport, Mayo!

This plant has only once been observed, but if its characters are constant it is a well-marked species. If the number of spiral ridges is variable it is probably only a form of *S. obscura* Ralfs.

12. **Spirotænia trabeculata** A. Br.

(Pl. V, fig. 6.)

Spirotænia trabeculata A. Br. in Rabenh. Alg. 1856, no. 543; De Bary, Conj. 1858, p. 75; Rabenh. Krypt. Fl. Sachs. 1863, p. 178; Lütkem. Gatt. Spirotæn. 1895, p. 5, 95, t. 1, f. 20; Nordst. Index Desmid. 1896, p. 256; West & G. S. West, Alg. N. Ireland, 1902, p. 19.

Cells of medium size, 5–7½ times longer than their diameter, subcylindrical, gradually attenuated from the middle towards the apices, which are subtruncate; chloroplast axile, scarcely reaching the extremities of the cell, cristate, with 5 or 6 slightly spiral ridges which are scarcely thickened at the free margin, pyrenoids many.

Zygospore unknown.

Length 142–210 μ; breadth 19–35 μ; breadth of apices 10·5–11·5 μ.

IRELAND.—Lough Anna, Donegal!

Geogr. Distribution.—Austria. Germany.

In the Irish specimens the chloroplast possessed six almost straight ridges, and extended the whole length of the cell with the exception of a very small space at each end. In many specimens the chloroplast was partially interrupted in the middle, and most of the examples appeared to be faintly constricted. The apices were distinctly more truncate than those figured by Lütkemüller, but Rabenhorst says "utroque polo truncata," and Lütkemüller has since remarked that the apices are probably subtruncate. It is a very rare species.

13. **Spirotænia acuta** Hilse.

(Pl. III, figs. 14, 15.)

Spirotænia acuta Hilse, in Rabenh. Alg. 1866, no. 1830; Rabenh. Flor. Europ. Alg. III, 1868, p. 148; Cooke, Brit. Desm. 1887, p. 185, t. 66, f. 5; Lütkem. Gatt. Spirotæn. 1895, pp. 56, 93; Nordst. Index Desmid. 1896, p. 39; West & G. S. West, Alga-fl. Yorks. 1900, p. 41; Alg. N. Ireland, 1902, p. 19.

Cells small, (2½–)5–8 times longer than their diameter, fusiform, tapering from the middle to the apices, which are acute; chloroplast axile, with several (3 or 4) spirally arranged ridges which sometimes anastomose. Pyrenoid usually solitary.

Zygospore unknown.

Length 30–37 μ; breadth 6–7·2 μ.

ENGLAND.—Pilmoor, N. Yorks! Hampsfell, Lancashire!

SCOTLAND.—Upper Powlair, Slewdrum, Culblean, Aberdeen; Den of Garrol and Dalbrake, Kincardine; Fintray Hills, Stirling (*Roy & Bissett*). Rhiconich, Sutherland! Near Balallan, Lewis; and near Tarbert, Harris, Outer Hebrides!

IRELAND.—Galway (*Archer*). Near Gweedore; Loughs Anna and Machugh, Donegal!

Geogr. Distribution.—Silesia in Germany. Austria.

This is a rare plant and is readily distinguished by the sharp apices of the cells. The chloroplast usually contains one pyrenoid and extends to the extreme points of the cells. The spiral ridges are generally three or four in number, rather irregular, and they frequently join together. Lütkemüller gives 18 μ as the length of his smallest specimen (only 2½ times longer than broad), but we have seen no British specimens so short as that.

14. **Spirotænia tenerrima** Arch.

Spirotænia tenerrima Arch. in Quart. Journ. Micr. Sci. 1870, p. 203; Cooke, Brit. Desm. 1886, p. 52; Lütkem. Gatt. Spirotæn. 1895, p. 54; Nordst. Index Desmid. 1896, p. 251; West & G. S. West, Alga-fl. Yorks. 1900, p. 41.

? *Spirotænia gracillima* Arch. in Quart. Journ. Micr. Sci. 1875, p. 116, t. 6; Nordst. Index Desmid. 1896, p. 133.

Cells minute, very slender, 20 times longer than their diameter, somewhat curved or arched and slightly attenuated towards the poles, apices truncate (?); chloroplast . . . . ?, forming a single spiral.

Length 31–42 μ; breadth 2·5–3·5 μ.

? [ENGLAND.—Pilmoor, N. Yorkshire! (Pl. III, figs. 16, 17.)]

IRELAND.—Dublin (*Archer*).

It is extremely doubtful whether the specimens from Yorkshire really belonged to this species, or to the Desmidiaceæ at all! The nature of the chloroplast was very obscure and the specimens may have been forms of *Rhaphidium fasciculatum* var. *aciculare*. It is also doubtful whether the forms described by Archer as two species are identical. For *S. tenerrima* he says: "Exceedingly slender, being, however, long as compared with the diameter; the cells somewhat curved or arched, slightly tapering, ends truncate, the endochrome forming a single spiral reaching from end to end of the cavity, self-division transverse;" and for *S. gracillima* he says: "Very minute, linear, extremely slender, very slightly tapering, apices blunt, spiral turns very numerous; a remarkable form from its extreme slenderness. Breadth 2·5–2·8 μ, about twenty times longer than broad." It may be that these plants are distinct species, but Archer's descriptions are insufficient.

Genus 4. **MESOTÆNIUM** Näg. 1849.

Näg. Gatt. einz. Alg. 1849, p. 108.
De Bary, Conj. 1858, p. 20, 30, 74.
Arch. in Proc. Dubl. Nat. Hist. Soc. 1864, p. 20.
Cooke, Brit. Desm. 1886, p. 47.
De Toni, Syll. Alg., 1889, p. 811.

Cells cylindrical or subcylindrical, usually straight, often slightly curved, not constricted, apices rounded or subtruncate; with a solitary chloroplast (more rarely with two chloroplasts), which is axile, flattened, and plate-like; pyrenoids one or several; nucleus frequently excentric.

Of the ten British species of this genus, only three occur as free-floating Desmids in quiet water. The remaining seven are found in gelatinous masses amongst mosses, principally on wet rocks.

The cells are frequently filled with large quantities of reserve products which completely obscure the choloroplast.

The British species are best arranged in the following manner:

A. Cells embedded in mucilaginous masses.

* Cell-sap uncoloured.
  † Cells cylindrical or ellipsoidal, poles rounded.
    Cells large, often curved, 3–5 times longer than broad.
      1. *M. De Greyi.*
    Cells of medium size, rarely curved, 1½–2½ times longer than broad.
      2. *M. mirificum.*
    Cells small, cylindrical, 2–2⅓ times longer than broad; diam. 15 μ.
      3. *M. macrococcum.*
    Cells small, cylindrical, 2–2⅓ times longer than broad; diam. 11–12 μ.
      4. *M. chlamydosporum.*
  †† Cells subcylindrical, poles attenuated.
      5. *M. caldariorum.*
  ††† Cells cylindrical, poles truncate.
      6. *M. truncatum.*
** Cell-sap normally coloured violet.
      7. *M. violascens.*

B. Cells free-swimming.

* Cell-sap coloured purple or violet.
8. *M. purpureum.*

** Cell-sap uncoloured.
† Cells straight, 3–4 times longer than broad.
9. *M. Endlicherianum.*
†† Cells curved, 6–8 times longer than broad.
10. *M. Kramstai.*

A. Cells in mucilaginous masses, principally on wet rocks.

1. **Mesotænium De Greyi** Turn.

(Pl. III, figs. 18, 19.)

Mesotænium De Greyi Turn. Notes Freshw. Alg. 1886, p. 34, t. 1, f. 1; Cooke, Brit. Desm. 1886, p. 48, t. 18, f. 6; West, Alg. W. Ireland, p. 131; Alg. Eng. Lake Distr. 1892, p. 721; West & G. S. West, Alg. S. England, p. 478; Alga-fl. Yorks. 1900, p. 41; Alg. N. Ireland, 1902, p. 19; Nordst. Index Desmid. 1896, p. 136.
Mesotænium Braunii De Bary, var. *Greyi* (Turn.) Roy in Scott. Nat. x, 1890, p. 206.

Cells large, 4–4½ times longer than their diameter, cylindrical, straight or curved, apices broadly rounded.

Zygospore unknown.

Length 76–104 μ; breadth 20–23 μ.

ENGLAND.—Bowness, Westmoreland! Blubberhouses (*Turner*), Ilkley, Simon Seat, and near Settle, W. Yorks! Puttenham Common, Surrey! Tintagel, Cornwall!

SCOTLAND.—Bræriach, Inverness; Tough, Glen Derry, and "Colonel's Bed," Aberdeen; Kyles of Bute, Argyll (*Roy & Bissett*).

IRELAND.—Castletown, Kerry! Lough Nacung, Donegal!

Geogr. Distribution.—Australia.

This is the largest species of the genus and the cells frequently become filled with reserve materials, often in the form of large oil globules.

Forma **major** *forma nov.* (Pl. III, fig. 21.)

Cells rather larger than in the typical form, and about 4 times longer than their diameter.

Length 97–123 μ; breadth 26–30 μ.

IRELAND.—Mourne Mts., Down.

This form occurred in gelatinous masses on rocks, mixed with other Desmids and numerous Diatoms. Many of the individuals were straight, the others being slightly curved.

Forma tenuis *forma nov.* (Pl. III, fig. 22.)

Cells rather narrower than in the typical form; a little more than 5 times longer than their diameter.

Length 83 μ; breadth 15·5 μ.

ENGLAND.—Epping Forest, Essex!

This form occurred in peaty ditches along with *Euastrum lobulatum* and *Tetmemorus granulatus*. It is of about the same length as the type, but is proportionately narrower. The cells were embedded in a mass of mucus produced principally by numerous specimens of *Vanheurckia rhomboides* var. *Saxonica*.

Var. breve West. (Pl. III, fig. 20.)

M. De Greyi var. *breve* West, Alg. W. Ireland, 1892, p. 131, t. 20, f. 6.

Cells almost straight or slightly curved, 2½ times longer than their diameter.

Length 58 μ; breadth 21–22 μ.

IRELAND.—Torc Mountain, Kerry!, on dripping rocks with *Amphoridium Mougeotii* and other mosses.

The cells of this variety are much shorter than those of the type, but in their breadth and other respects they are precisely similar.

2. Mesotænium mirificum Arch.

(Pl. IV, figs. 18, 19.)

Mesotænium mirificum Arch. Palmoglœa and descrip. Mesot. 1864, p. 19, t. 1, f. 20–31; Cooke, Brit. Desm. 1886, p. 47, t. 18, f. 3; West & G. S. West, Alga-fl. Yorks. 1900, p. 41; Nordst. Index Desmid. 1896, p. 173.
Palmoglœa mirifica Rabenh. Flor. Europ. Alg. III, 1868, p. 117.

Cells broadly elliptical or oblong-elliptical, 1½–2½ times longer than their diameter, straight or rarely slightly curved; chloroplast in the form of a very narrow axile plate which is often curved.

Zygospore unknown.

Length 25–42·5 μ; breadth 15–20 μ.

ENGLAND. — Stickle Tarn, Westmoreland! Ogden Clough and Ingleton, W. Yorks! Leicester (*Roy*).

WALES. —Llyn Idwal, Carnarvonshire!

SCOTLAND.—Harris, Outer Hebrides! Goat Fell, Arran!

IRELAND.—Dublin and Wicklow (*Archer*).

Archer observed the formation of asexual spore-like bodies in this plant; they were of a brown colour and of an average diameter of about 25 μ. He says: "I have observed the cell-contents bounded by the primordial utricle escape from the parent-cell without conjugation, through a lateral or terminal or intermediately disposed opening, effected by the raising up and often the separation of a lid or valve-like portion of the parent-cell membrane. During this operation the contents are often much constricted, by reason of the narrow orifice through which the mass makes an exit. After emergence it becomes rounded, and the contents of this resting-spore-like body, which do not conjugate or combine with any other, become of a reddish-brown hue, with a dark corpuscle in the centre. The empty parent-cell membrane lies hard by, the lid-like structure sometimes apparently still adherent by one point—sometimes wholly detached, and lying about in various positions, or lost altogether."

The elliptical outline of the cells is sufficient to distinguish this species from *M. macrococcum* and *M. chlamydosporum*.

3. **Mesotænium macrococcum** (Kütz.) Roy & Bissett. (Pl. III, figs. 34–36.)

Palmoglœa macrococca **Kütz. Phyc. germ. 1845, p. 153; Tab. Phycolog. 1847, I, t. 24, f. 2; Spec. Alg. 1849, p. 228; Rabenh. Flor. Europ. Alg. III, 1868, p. 115; Nordst. Index Desmid. 1896, p. 162; Arch. Palmoglœa and descrip. Mesot. 1864, p. 12-14.**

Mesotænium Braunii **De Bary, Conj. 1858, p. 74, t. 7 A, f. 1-8; Kirchn. Alg. Schles. 1878, p. 134; Wolle, Desm. U.S. 1884, p. 31, t. 3, f. 5-9; Turn. Freshw. Alg. E. India, 1893, p. 15.**

Mesotænium macrococcum **(Kütz.) Roy & Biss. Scott. Desm. 1894, p. 61 (sep.); West & G. S. West, Alga-fl. Yorks. 1900, p. 41.**

Cells cylindrical, 2–2½ times longer than their diameter, apices truncately rounded; chloroplast a strong axile plate, often with a toothed margin.

Zygospore somewhat quadrate with rounded angles.

Length 33–35 μ; breadth 15 μ.

ENGLAND.—W. Yorks! Leicester (*Roy*). Hants (*Roy*). Cornwall!

WALES.—Capel Curig (*Roy*), Moel Siabod!, Llyn Idwal!, Glyder Fawr, at 2,300 ft., Carnarvonshire!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth, Renfrew (*Roy & Bissett*).

IRELAND.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Galicia and Austria. Norway. Faeroes. India. United States.

Var. **micrococcum** (Kütz.) West & G. S. West. (Pl. IV, figs. 1–3.)

Palmoglœa micrococca Kütz. in Bot. Zeitung, 1847, p. 221; Tab. Phycolog. 1847, I, p. 20, t. 25, f. 5; Spec. Alg. 1849, p. 229; Rabenh. Flor. Europ. Alg. 1868, III, p. 116.

Mesotænium Braunii De Bary, var. *minus* De Bary, Conj. 1858, p. 74, t. 7 A, f. 9–11.

Mesotænium micrococcum Kirchn. Alg. Schles. 1878, p. 134; West, Alg. W. Ireland, 1892, p. 131.

M. macrococcum var. *micrococcum* West & G. S. West, Alga-fl. Yorks. 1900, p. 41.

Cells shortly cylindrical, 1½–2 times longer than their diameter, slightly attenuated towards the apices which are rounded.

Length 13·5–16·6 μ; breadth 8·4–10·2 μ.

ENGLAND.—Stickle Tarn, Westmoreland! Near Giggleswick, W. Yorks! Near Selby, E. Yorks!

WALES.—Glyder Fawr (at 2,200 ft.), Carnarvonshire!

SCOTLAND.—Cairngorm, Inverness; Dalbagie, Aberdeen (*Roy & Bissett*).

IRELAND.—Lakes, from Clifden to Roundstone, Galway! 8 miles S. of Kenmare, Kerry!

Geogr. Distribution.—France. Germany. Austria. Norway. Poland. Faeroes. United States. West Indies!

4. **Mesotænium chlamydosporum** De Bary.

(Pl. IV, figs. 4–14.)

Mesotænium chlamydosporum De Bary, Conj 1858, p. 75, t. 7 D; Nordst. Index Desmid. 1896, p. 73; West & G. S. West, Alga-fl. Yorks. 1900, p. 42.

Palmoglœa chlamydospora De Bary, in Rabenh. Alg. 1856, no. 514.
Mesotænium chlamydosporum var. β Arch. Palmoglœa and descrip. Mesot. 1864, p. 26, t. 1, f. 1–19; Cooke, Brit. Desm. 1886, p. 47, t. 18, f. 4.
Mesotænium chlamydosporum var. *Archeri* Rabenh. Flor. Europ. III, 1868, p. 117.

Cells oblong-cylindrical, 2–2½ times longer than their diameter, apices broadly rounded or rarely subtruncately rounded; chloroplast axile, forming a narrow plate.

Zygospore irregular, more or less polygonal, becoming brown; outer coat thick and involucrate.

Length 25–33 μ; breadth 11·5–12 μ; length of zygosp. 26–38 μ; breadth of zygosp. 21–26 μ.

ENGLAND.—Cautley Spout, Widdale Fell, Eldwick, and near Settle, W. Yorks! Lund's Fell, N. Yorks! Near St. Just, Cornwall!

WALES.—Capel Curig and Twll Du, Carnarvonshire!

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Perth (*Roy & Bissett*). Rhiconich, Sutherland! Lewis, Outer Hebrides! Goat Fell, Arran!

IRELAND.—Dublin and Wicklow (*Archer*). Slieve Donard, Down (at 2,000 ft.)!

Geogr. Distribution.—Germany. Sweden (var.). Poland. Faeroes. India. Argentina. West Indies.

Forma **minor** *forma nov.*

Mesotænium chlamydosporum West, Alg. W. Ireland, 1892, p. 131, t. 24, f. 8

Cells and zygospores similar to those of the typical form but smaller.

Length 16–21 μ; breadth 8·5–10 μ; diam. zygosp. 16–25 μ.

IRELAND.—Near Westport, Mayo!

Forms large gelatinous masses on wet rocks.

5. **Mesotænium caldariorum** (Lagerh.) Hansg.

(Pl. IV, figs. 15–17.)

Mesotænium Endlicherianum Näg. var. *caldariorum* Lagerh. Algol. Bidr. 1886, p. 48, f. 4 xylogr.

Mesotænium caldariorum (Lagerh.) Hansg. Prodr. Algenfl. Böhm. 1888, p. 174; ?Turn. Freshw. Alg. E. India, 1893, p. 15, t. 1, f. 23; West & G. S. West, Alga-fl. Yorks. 1900, p. 42.

Cells cylindrical or subcylindrical, 2½–4 times longer than their diameter, somewhat suddenly attenuated near the apices which are rounded; chloroplast axile, sometimes a little irregular and bent, often with one pyrenoid.

Zygospore unknown.

Length 27–46 μ; breadth 10·5–11·5 μ.

ENGLAND.—Bradford, Yorkshire! forming a gelatinous stratum in a greenhouse with *Dactylothece Braunii* Lagerh.

Geogr. Distribution.—Sweden. India? Ecuador.

We have previously mentioned that Turner's figure does not represent the species. It is a most characteristic *Mesotænium* owing to the sudden attenuation of the extremities of the cells; there is also an almost imperceptible narrowing of the middle region of the cells. It must be a very rare plant as we have only once obtained specimens of it.

6. **Mesotænium truncatum** *sp. nov.*

(Pl. V, fig. 12.)

Cells cylindrical, 3–3½ times longer than their diameter, apices broadly truncate; chloroplast axile, narrow, generally with a slight notch in the middle region of the cell, with two pyrenoids.

Zygospore unknown.

Length 31–35 μ; breadth 9·5–10 μ.

ENGLAND.—Cowgill Wold Moss, Widdale Fell, West Yorkshire!

This plant is readily distinguished from all other species of this genus by its broadly truncate apices. It resembles *Penium truncatum* Bréb. in its general outline but is at once distinguished by its plate-like chloroplast.

A few individuals were observed in which there were two plate-like chloroplasts, one in each half-cell. Sometimes one chloroplast was disposed in a plane at right angles to the other, so that the flat surface of one was seen concurrently with the edge of the other.

It was found amongst mosses on wet rocks.

7. **Mesotænium violascens** De Bary.

(Pl. III, figs. 27–33.)

Mesotænium violascens De Bary, Conj. 1858, p. 32, 74, t. 7, f. B; Cooke, Brit. Desm. 1886, p. 47, t. 18, f. 5; Nordst. Freshw. Alg. N. Zeal. 1888, p. 72.

Palmoglœa violascens Rabenh. Krypt. Fl. Sachs. 1863, p. 167; Flor. Europ. Alg. iii, 1868, p. 117.

Cells elliptico-cylindrical, 1½–2 times longer than their diameter, gradually attenuated towards the rounded apices; chloroplast an elliptical plate with one pyrenoid; cell-sap coloured violet.

Zygospore obtusely angular.

Length 24–33 μ; breadth 15–16·5 μ; diam. zygosp. 27–28 μ.

ENGLAND.—Leicester (*Roy*). Devil's Jumps at Frensham, Surrey! Enbridge Lake, Hants (*Roy*).

SCOTLAND.—Inverness, Nairn, Aberdeen, Forfar (*Roy & Bissett*). Craig-an-Lochan, Perth!

IRELAND.—Bray, Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Norway. Sweden. Lapland in Russia. New Zealand.

This plant is less cylindrical than most species of the genus, and its nearest ally is *M. mirificum* Arch. It is, however, scarcely so large as the latter species and not so elliptical in outline. Nordstedt gives as the dimensions of his New Zealand specimens: length 32–36 μ; breadth 20–21 μ. The cell-sap is coloured violet owing to the presence of phycoporphyrin.

B. Cells free-swimming.

8. **Mesotænium purpureum** West & G. S. West.

(Pl. III, figs. 25, 26.)

Mesotænium purpureum West & G. S. West, Notes Alg. I, 1898, p. 2 (sep.); Alga-fl. Yorks. 1900, p. 42.

Cells cylindrical and slightly curved, 3½–4½ times longer than their diameter, apices rounded; chloroplast plate-like and rather thick; cell-sap purple or violet in colour.

Zygospore unknown.

Length 32–46 μ; breadth 9·5–10 μ.

ENGLAND.—Old Cote Moor, West Yorkshire!, in peat bogs.

As in the previous species the cell-sap of this plant is coloured violet or purple by phycoporphyrin. *M. purpureum* is a free-swimming species and the chloroplast usually contains two pyrenoids. Sometimes, as in other species of this genus, the chloroplast is obscured by large globules of an oily reserve material.

9. **Mesotænium Endlicherianum** Näg.

(Pl. IV, figs. 20, 21.)

Mesotænium Endlicherianum Näg. Gatt. einz. Alg. 1849, p. 109, t. 6 B; Kirchn. Alg. Schles. 1878, p. 134; Wolle, Desm. U.S. 1884, p. 32, t. 3, f. 11; Roy & Biss. Scott. Desm. 1894, p. 61 (sep.); West & G. S. West, Some Desm. U.S. 1898, p. 281; Alg. N. Ireland, 1902, p. 19; Alga-fl. Yorks. 1900, p. 42; Nordst. Index Desmid. 1896, p. 118.

Palmoglœa Endlicheriana Rabenh. Flor. Europ. Algar. III, 1868, p. 116.

Cells cylindrical, 3–4 times longer than their diameter, apices broadly rounded; chloroplast an axile plate, pyrenoids one in each semicell.

Zygospore unknown.

Length 25–27 μ; breadth 8–9·5 μ.

ENGLAND. — W. and N. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Cornwall!

WALES.—Bog below Llyn Idwal, Glyder Fach (at 2,200 ft.), Glyder Fawr (at 2,600 ft.), Llyn Cwlyd, Llyn Pencraig near Bettws-y-coed, Carnarvonshire!

SCOTLAND.—Sutherland, Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth, Stirling, Renfrew (*Roy & Bissett*).

IRELAND.—Near Gweedore and near Glenties, Donegal! Bog near Lough Neagh, Londonderry!

Geogr. Distribution.—Germany. Switzerland. Galicia and Austria. S. Russia. Australia. W. Indies. United States.

This species sometimes occurs in quantity in boggy pools or at the boggy margins of mountain lakes and tarns.

Var. **grande** Nordst. (Pl. IV, fig. 22.)

M. Endlicherianum var. *grande* Nordst. in Wittr. & Nordst. Alg. Excis. 1879, no. 271; Lagerh. Phycoporph. 1895, p. 24; Wittr., Nordst., & Lagerheim, Alg. Exsic. 1896, fasc. 29, no. 1400; West & G. S. West, Alg. S. England, 1897, p. 478; Alga-fl. Yorks. 1900, p. 42.

A larger variety, often twice as large as the type, with two pyrenoids in each semicell; cell-sap often violet.

Zygospore globose; cell-wall thick and smooth.

Length 50–54 μ; breadth 12–13 μ; diam. zygosp. 26–28 μ.

ENGLAND.—Cragg Vale, Cocket Moss near Giggleswick, and near Settle, W. Yorks! Epping Forest, Essex!

WALES.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—Germany. Norway.

10. **Mesotænium Kramstai** Lemm.

(Pl. III, figs. 23, 24.)

Mesotænium Kramstai Lemm. Algenfl. Riesengebirges, 1896, p. 115, 116, 8–10; Nordst. Index Desmid. 1896, p. 277; G. S. West, Alga-fl. Cambr. 1899, p. 110.

Cells cylindrical, often slightly curved, 6–8 times longer than their diameter, apices rounded or truncately rounded; chloroplast an elongated plate.

Zygospore unknown.

Length 44–104 μ; breadth 9–13 μ.

ENGLAND.—Chippenham Fen, Cambridgeshire!

Geogr. Distribution.—Germany. W. Indies (var.).

This is the most elongate species of the genus and in its external form greatly resembles some of the smaller forms of *Roya obtusa*. The chloroplast is commonly obscured by dense masses of oil globules.

Genus 5. **CYLINDROCYSTIS** Menegh. 1838.

Menegh. Monogr. Nostoch. 1842, p. 88.
Hassall, Brit. Freshw. Alg. 1845, p. 361.
De Bary, Conj. 1858, p. 30, 35, 74.

Archer, Observations on *Cylindrocystis*, 1866, p. 206.
Gay, Monogr. loc. Conj. 1884, p. 34.
Cooke, Brit. Desm. 1886, p. 46.
De Toni, Syll. Alg. 1889, p. 815.

Cells cylindrical, about twice longer than their diameter, often embedded in mucilage, unconstricted or with a slight median constriction, apices generally rounded; with one axile, substellate chloroplast in each semicell; pyrenoids large, one in the centre of each chloroplast.

The principal character of this genus is the presence in each semicell of a somewhat stellate chloroplast. In the centre of the semicell is a large pyrenoid, and radiating from it in every direction are processes and prolongations of the chloroplast, which often flatten themselves against the inner surface of the cell-wall. During conjugation the cell-walls of the gametangia become confluent round the zygospore in some species, but not in others.

A. Cells unconstricted.

1. **Cylindrocystis Brébissonii** Menegh.

(Pl. IV, figs. 23–32; Pl. V, fig. 10.)

Cylindrocystis Brébissonii **Menegh. 1838; Monogr. Nostoch. 1842, p. 89, t. 12, f. 13; Hass. Brit. Freshw. Alg. 1845, p. 361, t. 92, f. 17; De Bary, Conj. 1858, p. 35, 46, 74, t. 7, f. E 1–22; West, Alg. W. Ireland, 1892, p. 131; Roy & Biss. Scott. Desm. 1894, p. 62 (sep.); West & G. S. West, Alga-fl. Yorks. 1900, p. 43; Alg. N. Ireland, 1902, p. 20.**

Palmoglœa Brébissonii **Kütz. Tab. phycolog. I, 1847, p. 19, t. 24, f. 4; Spec. Alg. 1849, p. 229.**

Penium Brébissonii **Ralfs, Brit. Desm. 1848, p. 153, t. 25, f. 6?; Rabenh. Flor. Europ. Alg. III, 1868, p. 120; Delp. Desm. subalp. p. 88, t. 14, f. 28–36; Kirchn. Alg. Schles. 1878, p. 136; Wolle, Desm. U.S. 1884, p. 36, t. 5, f. 7–8; Cooke, Brit. Desm. 1886, p. 43, t. 17, f. 3; West, Alg. N. Yorks. 1889, t. 291, f. 3.**

Cells cylindrical, unconstricted, about 2–3 times longer than their diameter, apices rounded; chloroplasts usually with few large radiating prolongations and often difficult of observation.

Zygospore quadrate at first, and afterwards spherical or subspherical or subquadrate.

Length 43–55 μ; breadth 15–18 μ; diam. zygosp. 30–48·5 μ.

ENGLAND.—Widely distributed all over the country. Zygospores from Westmoreland, Yorkshire, and Surrey!

WALES.—Common and often with zygospores! Up to 2,200 ft. on Glyder Fach!

SCOTLAND. — General and frequently conjugated! (*Roy & Bissett*). Up to 3,500 ft. on Lochnagar! Outer Hebrides! Orkneys! Shetlands!

IRELAND.—General and often abundant!

Geog. Distribution.—Generally distributed in Europe. Faeroes. Iceland. Greenland. Spitzbergen. Nova Zembla. Franz-Joseph Land. India. Siam. Java. Australia. New Zealand. E. Africa. North and South America. West Indies. Azores.

Pure gatherings of this species are not uncommon, especially in peaty districts, often at elevations of over 2,000 ft. It sometimes occurs on vertical faces of peat on mountains subject to frequent mists and rain. It is one of the commonest of British Desmids, and occurs in all kinds of damp and wet situations.

Var. **minor** West & G. S. West. (Pl. V, fig. 11.)

C. Brébissonii var. *minor* West & G. S. West, Alg. N. Ireland, 1902, p. 20, t. 2, f. 7.

Cells narrower and shorter than in the typical form.

Length 27–41 μ; breadth 12·5–13 μ; length of zygosp. 33 μ, breadth 30 μ.

ENGLAND.—Mickle Fell and Strensall Common, N. Yorkshire (with zygospores)!

SCOTLAND.—Pure gathering from Sligachan in Skye, Inverness!

IRELAND.—Lough Fea, Londonderry (with zygospores)!

2. **Cylindrocystis crassa** De Bary.
(Pl. IV, figs. 33–38.)

Cylindrocystis crassa De Bary, Conj. 1858, p. 37, 74, t. 7, f. C 1–12; Nordst. in Wittr. & Nordst. Alg. Exsic. 1879, no. 269; Cooke, Brit. Desm. 1886, p. 46, t. 18, f. 2; West, Alg. W. Ireland, 1892, p. 131; West & G. S. West, Alga-fl. Yorks. 1900, p. 43; Alg. N. Ireland, 1902, p. 20; Desm. Singapore, 1897, p. 156; Alg. S. England, 1897, p. 478.
Penium crassa Wolle, Desm. U.S. 1884, p. 37, t. 5, f. 3.

Cells oblong-cylindrical, 1½–2 times longer than their diameter, apices broadly rounded; chloroplast similar to that of the preceding species.

Zygospore globose or rarely subquadrangular.

Length 22–46 μ; breadth 18–24 μ; diam. zyposp. 25–30 μ.

ENGLAND.—Cumberland! Westmoreland! Yorks! Lancashire! Cheshire (*Roy*). Leicester (*Roy*). Essex! Surrey! Hants! (*Bennett*). Cornwall!

WALES.—Fairly general in Carnarvonshire; up to 2,700 ft. on Glyder Fawr!

SCOTLAND.—General! (*Roy & Bissett*). Harris and Lewis, Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Galway! Kerry! Dublin and Wicklow (*Archer*). Donegal! Londonderry! Down!

Geogr. Distribution.—France. Germany. Austria. Portugal. Sweden. Norway. Singapore. Madagascar. New Zealand. West Africa. United States.

3. **Cylindrocystis obesa** West & G. S. West.

(Pl. V, fig. 8.)

Cylindrocystis obesa **West & G. S. West, Alg. N. Ireland, 1902, p. 20, t. 2, f. 6.**

Cells of medium size, about 1¾ times longer than their diameter, rhomboid-ellipsoid with the apices broadly rounded, unconstricted; cell-wall smooth and colourless; chloroplasts stellate with numerous radiating processes, pyrenoids very large; with a distinct vacuole near each apex.

Zygospore unknown.

Length 48 μ; breadth 27 μ.

IRELAND.—Near Gweedore, Co. Donegal!

This species bears considerable resemblance to *C. pyramidata* West & G. S. West, a plant only known from Ceylon, but is distinguished by its relatively greater width, the more rounded apices, and the absence of a constriction. (Consult West & G. S. West, Freshw. Alg. Ceylon, p. 134, t. 18, f. 1, 2).

B. Cells very slightly constricted.

4. **Cylindrocystis diplospora** Lund.

(Pl. IV, figs. 40, 41.)

Cylindrocystis diplospora Lund. Desm. Suec. 1871, p. 83, t. 5, f. 7; Cooke, Brit. Desm. 1886, p. 46, t. 18, f. 1; Roy & Biss. Scott. Desm. 1894, p. 62 (sep.); West & G. S. West, Alg. S. England, 1897, p. 478; Alga-fl. Yorks. 1900, p. 44; Alg. N. Ireland, 1902, p. 20.
Penium diplosporum Jacobs. Desm. Danem. 1875, p. 164.
? *Schizospora pachyderma* Reinsch, Contrib. Alg. et Fung. 1875, p. 87, t. 17, f. 1.
Calocylindrus diplosporus Wolle, in Bull. Torr. Bot. Club. 1882, p. 15; Desm. U.S. 1884, p. 56, t. 12, f. 18.

Cells moderately large, twice longer than their diameter, subcylindrical, slightly constricted in the middle, gradually but faintly dilated towards the apices which are truncately rounded; cell-wall slightly thickened at the apex, smooth and colourless; chloroplasts with numerous radiating processes.

Zygospore *double*, compressed, transversely subrectangular with the external angles rounded.

Length 52·5–66 μ; breadth 22·5–33 μ; breadth of zygosp. 66 μ; length of half zygosp. 38–42 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W. and N. Yorks! Lancashire! Essex! Surrey! Hants! Devon (*Bennett*). Cornwall! (*Bennett*).

WALES.—Capel Curig, Llyn Idwal, and Bethesda, Carnarvonshire! Ffestiniog, Merioneth!

SCOTLAND.—Sutherland!, Ross!, Inverness!, Aberdeen, Kincardine, Perth!, Argyll; often conjugated (*Roy & Bissett*). Orkneys! Outer Hebrides!

IRELAND.—Galway! Kerry! Wicklow (*Archer*). Donegal! Londonderry! Antrim! Down!

Geogr. Distribution.—Germany. Norway. Sweden. Denmark. Lapland in Russia. Greenland. India. New Zealand. East Africa (var.). United States.

Var. **major** West. (Pl. IV, figs. 42, 43.)

C. diplospora var. *major* West, Alg. W. Ireland, 1892, p. 131, t. 20, f. 3; West & G. S. West, New Brit. Freshw. Alg. 1892, p. 4, t. 1, f. 9; Alga-fl. Yorks. 1900, p. 44 (forma *constricta*); Roy & Biss. Scott. Desm. 1894, p. 62 (sep.).

More cylindrical than the typical form and almost twice the size; sometimes unconstricted, but more often with a slight constriction.

Length 102–114 μ; breadth 48–54 μ.

ENGLAND.—Pilmoor, N. Yorks! Riccall Common, E. Yorks!

SCOTLAND.—Deeside, Aberdeen (*Roy & Bissett*).

IRELAND.—Lakes, from Clifden to Roundstone, Galway!

Roy and Bissett found in Kincardine at Dalbrake in Strachan a smaller form of this variety which was the exact counterpart of the large one except for size; length 56 μ; breadth 25 μ. They also remark that "when seen side by side in the same gathering with *C. diplospora* it looks very different from that species."

5. **Cylindrocystis roseola** Turn.

(Pl. IV, fig. 39.)

Cylindrocystis roseola Turn. Desm. Notes, 1893, p. 346, f. 18; Nordst. Index Desmid. 1896, p. 225.

Cells subcylindrical, about 2½ times longer than their diameter, with a gradual constriction in the middle of the cell, attenuated towards the apices which are rounded and slightly thickened; cell-wall smooth, yellowish-pink or bright pink in colour.

Zygospore unknown.

Length 46–52 μ; breadth 19–21 μ.

WALES.—Near Dolbadarn Castle, Carnarvonshire (*W. B. Turner*).

6. **Cylindrocystis minutissima** Turn.

(Pl. V, fig. 9.)

Cylindrocystis minutissima Turn. Freshw. Alg. E. India, 1893, p. 16, t. 1, f. 24; West & G. S. West, Alg. N. Ireland, 1902, p. 20; Freshw. Alg. Ceylon, 1902, p. 134.

Cells minute, about twice longer than the diameter, with a slight median constriction, apices rounded; each chloroplast with a prominent pyrenoid.

Zygospore unknown.

Length 10·5–13 μ; breadth 5·5–7 μ.

IRELAND.—Lough Neagh!; along the shores.

Geogr. Distribution.—India. Ceylon.

We think this plant is correctly placed in the genus *Cylindrocystis*, and it is much the smallest known species. The Irish specimens were a little smaller than those observed from India, but otherwise were very similar.

Genus 6. **NETRIUM** (Näg. 1849).

Näg. Gatt. einz. Alg. 1849, p. 107 (subgenus of *Closterium*).
Itzigs. & Rothe, in Rabenh. Alg. 1856, no. 508 (genus without description).
Lütkem. Zellmembr. Desmid. 1902, p. 395, 396, 407.

Cells straight, cylindrical, subcylindrical, or fusiform, without any median constriction; cell-wall unsegmented, without pores, destitute of a differentiated outer layer and quite smooth; chloroplasts two (in one species four), one (in one species two) in each semicell, each chloroplast axile with about six radiating longitudinal plates which are conspicuously notched at their free edges (in all except *N. interruptum*); pyrenoids several in each chloroplast, arranged in a median series or sometimes scattered.

The establishment of this genus was suggested by Lütkemüller in order to include four forms which obviously do not belong to the Placoderm Desmids. The present genus *Penium* is the most artificial of the genera of Desmids, containing in addition to its true members quite a number of widely different forms, some of which really belong to the Cosmarieæ, others to the Closterieæ, and those now included in the genus *Netrium* which belong to the Spirotænieæ.

The species included under the generic name *Netrium* have long been considered as forms of *Penium*, but the structure of the cell-wall—the absence of segmentation and of the differentiated outer layer—places these plants at once in the tribe Spirotænieæ.

The chloroplasts are axile and are furnished with a number (generally six) of radiating longitudinal plates, and so far they resemble those of the genus *Penium;* but in three out of the four species of *Netrium* the free edges of the plates possess conspicuous notches which are never present in the chloroplasts of *Penium,* and the fourth species has each chloroplast transversely segmented so that four are present in the cell.

1. **Netrium Digitus** (Ehrenb.) Itzigs. & Rothe.

(Pl. VI, figs. 14–16.)

Closterium Digitus Ehrenb. Entwick. Lebens. d. Infus. 1832, p. 68; Infus. 1838, p. 94, t. 6, f. iii; Menegh. Synops. Desm. 1840, p. 236; Hass. Brit. Freshw. Alg. 1845, p. 376, t. 88, f. 4; Focke, Phys. Stud. I, 1847, p. 68, t. 3, f. 22.

Closterium lamellosum Bréb. Alg. Falaise, 1835, p. 59, t. 8.

Penium Digitus Bréb. in Ralfs' Brit. Desm. 1848, p. 150, t. 25, f. 3; Arch. in Pritch. Infus. 1861, p. 751; Rabenh. Flor. Europ. Alg. 1868, iii, p. 118; Delp. Desm. Subalp. 1877, p. 86, t. 15, f. 50, 51; Kirchn. Alg. Schles. 1878, p. 134; Wolle, Desm. U.S. 1884, p. 34, t. 53, f. 1; Cooke, Brit. Desm. 1886, p. 40, t. 16, f. 1; Hauptfl. Zellmembr. u. Hüllgallerte Desm. 1888, p. 101, t. 3, f. 62; West, Alg. W. Ireland, 1892, p. 127; Lütkem. Desm. Attersees, 1893, p. 544; Roy & Biss. Scott. Desm. 1894, p. 251; West & G. S. West, Rec. publ. Desm. 1895, p. 66; Alg. S. England, 1897, p. 478; Alga-fl. Yorks. 1900, p. 44; Alg. N. Ireland, 1902, p. 21; Some Desm. U.S. 1898, p. 282; Freshw. Alg. Ceylon, 1902, p. 134.

Penium lamellosum Kütz. Spec. Alg. 1849, p. 168; Bréb. Liste Desm. 1856, p. 146, t. 2, f. 34; Kirchn. Alg. Schles. 1878, p. 135; Wolle, Desm. U.S. 1884, p. 34, t. 5, f. 4; Lütkem. Desm. Attersees, 1893, p. 545.

Netrium Digitus (Ehrenb.) Itzigs. & Rothe in Rabenh. Alg. 1856, no. 508; Lütkem. Zellmembr. Desmid. 1902, p. 407.

Penium Digitus forma *curta* Anderss. Sverig. Chlor. 1890, I, p. 19, t. 1, f. 14.

Penium Digitus forma *recta* Turn. Freshw. Alg. E. India, 1893, p. 18, t. 1, f. 27.

Penium Navigium Turn. Freshw. Alg. E. India, 1893, p. 17, t. 1, f. 9.

Penium Digitus var. *montanum* Lemm. Algenfl. Riesengebirges, 1896, p. 120, f. 15–17.

Cells of variable size, generally large, 3–4 times longer than their diameter, not constricted, elliptic-oblong, gradually attenuated from the middle towards the apices which are rounded truncate; chloroplasts axile with about six longitudinal plates, deeply notched at the free margins; cell-wall smooth.

Zygospore spherical, smooth and thick-walled.

Length 130–387 μ; breadth 40–82 μ; breadth near apices 18–40 μ; diam. zygosp, 73·6 μ; thickness of wall of zygosp. 3·2 μ.

ENGLAND.—Only abundant in boggy and peaty districts. Cumberland! Westmoreland! (*Ralfs*). Yorks! Lancashire! Cheshire (*Roy*). Leicester (*Roy*). Warwick (*Wills*). Cambridge! Gloucester (*Ralfs*). Essex! Kent! Surrey! Hants! Devon! (*Bennett*). Cornwall! (*Ralfs*).

WALES.—General and often abundant; at 2,700 ft. on Glyder Fawr, Carnarvonshire!

SCOTLAND.—General and abundant! Zygospore from Cambus O'May, Deeside, Aberdeen (*Roy & Bissett*). Common in the Outer Hebrides! Orkneys! Shetlands!

IRELAND.—General and abundant!

Geogr. Distribution.—Generally distributed in Europe. Faeroes. India. Ceylon. Siam. Java. Central China. Japan. Australia. New Zealand. Azores. United States. British Guiana. Brazil.

This Desmid exhibits considerable variation in form and size, and the distinction between it and *Penium lamellosum* completely breaks down on the careful examination of numerous specimens. Particularly is this the case with regard to the pure gatherings which can often be made in peaty districts. It is frequently attenuated near the apices.

Var. **constrictum** *nob.* (Pl. VI, fig. 17.)

***Penium Digitus* var. *constrictum* West, Alg. W. Ireland, 1892, p. 127; West & G. S. West, Alg. S. England, 1897, p. 479; Freshw. Alg. Ceylon, 1902, p. 134.**

Cells 6–8 times longer than their diameter, gently narrowed in the median portion.

Length 353–405 μ; max. breadth 55–65 μ; breadth in middle of cells 47–55 μ.

ENGLAND.—New Forest, Hants!

SCOTLAND.—New Galloway, Kircudbright! Moidart, Inverness!

IRELAND. — Lakes, from Clifden to Roundstone, Galway!

Geogr. Ditstribuion.—Lapland in Russia.

2. **Netrium Nägelii** (Bréb.) *nob.*

(Pl. VII, figs. 4, 5.)

Closterium (*Netrium*) *Digitus* Näg. Gatt. einz. Alg. 1849, p. 107, t. 6, f. D.
Penium Nägelii Bréb. apud Arch. in Pritch. Infus. 1861, p. 751; Rabenh. Flor. Europ. Alg. 1868, III, p. 119; Cooke, Brit. Desm. 1886, p. 42, t. 16, f. 4; Schmidle Beitr. alp. Alg. 1895, p. 311, t. 14, f. 31; West & G. S. West, Alg. S. England, 1897, p. 479.

Cells of medium size, about 4½ times longer than their diameter, not constricted, oblong-lanceolate, apices broadly but truncately rounded; chloroplasts axile, with from four to six longitudinal radiating plates which are notched at the free margins; sometimes large terminal vacuoles are present containing a number of moving granules.

Zygospore unknown.

Length 115–160 μ; breadth 25–34 μ.

ENGLAND.—Sutton Park, Warwick (*Wills*). Enbridge Lake (*Roy*). New Forest, Hants!

WALES.—Capel Curig! (*Cooke & Wills*). Moel Siabod, Carnarvonshire!

SCOTLAND.—General (*Roy & Bissett*). Rhiconich, Sutherland! Moidart, Inverness! Near Tarbert, Harris, Outer Hebrides!

IRELAND.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Switzerland. Norway. Sweden. Lapland in Russia. Australia. New Zealand. East Africa. Brazil.

This species bears considerable resemblance to *N. Digitus*, but is of smaller size and somewhat narrower. It is a very uncommon plant in the British Islands and we have not seen many specimens of it.

3. **Netrium oblongum** (De Bary) Lütkem.

(Pl. VIII, figs. 1–3.)

Penium oblongum De Bary, Conj. 1858, p. 42, 73, t. 7 G, f. 1, 2; Rabenh. Flor. Europ. Alg. 1868, III, p. 119, fig. xylogr. p. 102; Delp. Desm. subalp. 1877, p. 86, t. 15, f. 40–42; ? Wolle, Desm. U.S. 1884, p. 34, t. 5, f. 17; West & G. S. West, Alga-fl. Yorks. 1900, p. 45; Alg. N. Ireland, 1902, p. 21.
Netrium oblongum (De Bary) Lütkem. Zellmembr. Desmid. 1902, p. 407.

Cells of medium size, 3–4 times longer than their diameter, not constricted, oblong-cylindrical, gradually narrowed towards the rounded apices; chloroplasts axile, with six longitudinal plates which are deeply notched along their free margins.

Zygospore spherical (according to Wolle).

Length 96–135 μ; breadth 32–33 μ.

ENGLAND.—Common in the upland districts of Westmoreland and Yorks! Surrey! Devon! Cornwall!

WALES.—General in Carnarvonshire!

SCOTLAND.—Sutherland! Ross, Aberdeen, Kincardine, Forfar!, Perth!, Argyll, Arran (*Roy & Bissett*). Inverness! Lanark! Dumfries! Lewis and Harris, Outer Hebrides!

IRELAND.—Frequent in Donegal! Lough Fea, Londonderry! Wicklow and Dublin (*Archer*).

Geogr. Distribution.—Germany. Austria. Hungary. Norway. Sweden. Lapland in Russia. Faeroes. India. West and East Africa. Somaliland. Ecuador. Brazil. United States.

This plant occurs abundantly in the upland bogs of most parts of the British Islands, particularly amongst *Sphagnum* in peaty pools. Apart from its smaller size, its form alone is sufficient to distinguish it from most forms of *N. Digitus*.

Var. **cylindricum** West & G. S. West. (Pl. V, fig. 7.)

N. oblongum var. *cylindricum* West & G. S. West, Notes Alg. III, 1903, p. 8 (sep.), t. 446, f. 10.

Cells smaller than in the typical form and exactly cylindrical; apices hemispherical; chloroplasts as in the typical form.

Length 57–73 μ; breadth 17–18·5 μ.

ENGLAND.—Helvellyn, Westmoreland!

WALES.—Capel Curig, Moel Siabod, Llyn Idwal, Llyn Cwlyd and Llyn Gwynant, Carnarvonshire!

SCOTLAND.—Near Tarbert, Harris, Outer Hebrides!

Geogr. Distribution.—Italy. Somaliland.

This variety is often abundant in the boggy portions of upland moors, round the margin of lakes, etc., frequently occurring mixed with the typical plants. It is readily distinguished from the typical form by its small size and exactly cylindrical cells, which are not attenuated towards the apices.

4. **Netrium interruptum** (Bréb) Lütkem.

(Pl. VII, figs. 1, 2.)

Penium interruptum Bréb. in Ralfs' Brit. Desm. 1848, p. 151, t. 25, f. 4; De Bary, Conj. 1858, p. 42–44, 46, 73, t. 5, f. 1–4; Arch. in Pritch. Infus. 1861, p. 751, t. 3, f. 45; Rabenh. Flor. Europ. Algar. 1868, III, p. 119; Delp. Desm. subalp. 1877, p. 79, t. 15, f. 1–9; Wolle, Desm. U.S. 1884, p. 35, t. 5, f. 14, 15; Cooke, Brit. Desm. 1886, p. 41, t. 16, f. 2; Hauptfl. Zellm. u. Hüllgallerte Desm. 1888, p. 101, t. 3, f. 61; West, Alg. W. Ireland, 1892, p. 127; Roy & Biss. Scott. Desm. 1894, p. 59 (sep.); Nordst. Index Desmid. 1896, p. 148; West & G. S. West, Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 45; Alg. N. Ireland, 1902, p. 21,

Closterium (Netrium) interruptum Reinsch, Algenfl. Frank. 1867, p. 185.

Netrium interruptum (Bréb.) Lütkem. Zellmembr. Desmid. 1902, p. 407.

Cells large, 4–6 times longer than their diameter, not constricted, cylindrical, near each extremity becoming suddenly conical, apices obtusely rounded; chloroplasts four, two in each semicell, median ones cylindrical, apical ones conical, each chloroplast with about eight longitudinal plates, free margins of plates entire; apical vacuole conspicuous and containing a solitary moving granule.

Zygospore unknown.

Length 220–320 μ; breadth 37–64 μ.

ENGLAND.—Cumberland! Westmoreland! N. Yorks! Lancashire! Cheshire (*Roy*). Warwick (*Wills*). Sussex (*Ralfs*). Surrey! Hants (*Roy*). Cornwall! (*Ralfs*).

WALES.—Capel Curig! (*Cooke & Wills*), Llyn Idwal, Llyn-y-cwm-ffynon, and near Dolbadarn Castle, Carnarvonshire!

SCOTLAND.—Ross, Inverness!, Aberdeen, Kincardine, Forfar, Perth! (*Roy & Bissett*). Lewis, Outer Hebrides!

IRELAND.—Near Westport, Mayo! Loughs Creggan and Aunierin, Galway! Dublin and Wicklow (*Archer*). Slieve Donard, Down!

Geogr. Distribution.—France. Germany. Austria.

Italy. Hungary. Norway. Sweden. Russia. Lapland. United States.

This species is well characterized by the transverse division of the chloroplasts, so that four are present in each cell, arranged in a longitudinal series. The conical apices also enable it to be easily distinguished from other species of *Netrium* and of *Penium*. The radiating longitudinal plates of the chloroplasts resemble those of *Penium* more than the other species of *Netrium* by reason of the entire, free edges, but the structure of the cell-wall places this plant in the Spirotænieæ.

Var. **sectum** *nob.* (Pl. VII, fig. 3.)

Penium interruptum var. *sectum* West, Alg. W. Ireland, 1892, p. 127; Nordst. Index Desmid. 1896, p. 148.

A variety with the apices suddenly truncate; cell-wall becoming brown in colour.

Length 258 μ; breadth 47 μ; breadth of apices 20–22 μ.

IRELAND.—Near Westport, Mayo!

Sub-family II. PLACODERMÆ.

In this sub-family the cell-wall is segmented and is differentiated into an inner and an outer layer. The inner layer is structureless and consists of cellulose. The outer layer is firmer and thicker, and in most Desmids of this sub-family it consists of a ground-substance of cellulose through which pass numerous tube-like structures known as "pore-organs." The latter do not consist of cellulose, and through each one runs a minute canal. The contents of the canals also pass through the inner layer of the cell-wall and usually terminate on its internal surface in a slight lens-shaped thickening or bulbous swelling. From the external end of the canal delicate club-shaped or flower-shaped structures frequently arise, and these curious structures, which are of a tough gelatinous consistency, have frequently given rise to erroneous conceptions of the nature of the firmer part of the cell-wall. They are sometimes prominent features of living specimens of *Cosmarium*, *Arthrodesmus*, *Staurastrum*, and other genera. The large mass of enveloping jelly which is often present in the placoderm Desmids is the result of a secretion of the cell-protoplasm, the products passing outwards through the pores. This external gelatinous coat commonly exhibits a radiating structure which has sometimes given rise to grave misconceptions.*

This group includes the vast majority of Desmids, and there is almost always a distinct demarcation between the new and the old semicells, the younger part of the cell-wall being joined to the older part by a narrow, bevelled surface.

Cell-division is of a fixed type, following strictly after the manner of previous cell-divisions, and the younger semicells are always interpolated between the old ones.

A. Point of division of cells variable or sometimes fixed (at the isthmus).

---

* Such was the case with *Xanthidium spinulosum* Bennett.

Tribe 3. PENIEÆ.

The cells are of moderate length, straight and usually cylindrical, sometimes with a slight median constriction. The points of division are often variable, although the actual divisions conform to the same type. The cell-wall may be with or without pores, and the cell frequently grows periodically by the interpolation of new cylindrical pieces of cell-wall until maturity is reached. There is only one genus in the tribe.

Genus 7. **PENIUM** Bréb., 1844.

Bréb. in Dict. univ. hist. nat. 1844, vol. iv, p. 513; in Ralfs' Brit. Desm. 1848, p. 148.
Kütz. Spec. Alg. 1849. p. 167.
Arch. in Pritch. Infus. 1861, p. 720 and 750.
Rabenh. Flor. Europ. Alg. 1868, III, p. 118.
Gay, Monogr. loc. Conj. 1884, p. 38.
Cooke, Brit. Desm. 1886, p. 38.
De Toni, Syll. Alg. 1889, p. 855.

Cells straight, cylindrical, subcylindrical, ellipsoidal or fusiform, unconstricted or with a slight median constriction, apices rounded, subtruncate or truncate; with one axile chloroplast in each semicell, consisting of a central mass with several radiating longitudinal plates which are entire at their free edges; pyrenoids one or more in each chloroplast, arranged in an axile series; cell-wall commonly with pores.

The genus *Penium* as now constituted is undoubtedly an artificial one, including Desmids of widely different affinities. As our knowledge is at present insufficient to relegate these plants to their true positions we have still retained them in the genus *Penium.*

We have so framed both the definition of the tribe Penieæ and of the genus *Penium* as to include *all* these plants, although a certain section of them represented by *Penium margaritaceum, P. cylindrus,* and others, would form a well-marked genus clearly differentiated from the rest of the Placoderm Desmids.

For the present the British species may be arranged as follows:—

SECTION A. (*Holopenium* Gay). Cells unconstricted, usually with no distinct demarcation between the old and the young semicells. Cell-wall smooth.

* Cells attenuated towards each end, never cylindrical.
1. *P. Libellula.*
2. *P. Navicula.*

** Cells cylindrical or ellipsoidal.
† Poles rounded.
3. *P. Jenneri.*
4. *P. spinospermum.*
5. *P. didymocarpum.*
6. *P. Mooreanum.*
7. *P. suboctangulare.*
8. *P. minutissimum.*

†† Poles truncate.
9. *P truncatum.*

SECTION B. (*Sphinctopenium* Gay). Cells either conspicuously constricted in the middle or very slightly constricted; always with a distinct demarcation between the newer and the older parts of the cell-wall.

* Cell-wall minutely or coarsely granulate.
† Cell-wall granulate over its entire surface.
10. *P. margaritaceum.*
11. *P. cylindrus.*
12. *P. cuticulare.*
13. *P. exiguum.*
14. *P. granulatum.*

†† Granules restricted to the poles.
15. *P. Clevei.*

** Cell-wall striated.
† Cells large, striations very distinct, spirally disposed.
16. *P. spirostriolatum.*

†† Cells small, striations longitudinal and faint.
17. *P. polymorphum.*
18. *P. phymatosporum.*

*** Cell-wall smooth, punctate, or finely scrobiculate.
† Cells minute, rounded, 1½ times longer than broad.
19. *P. subtile.*

†† Cells 2–4 times longer than broad.
α. Cell-wall scrobiculate or punctate.
20. *P. adelochondrum.*
21. *P. lagenarioides.*
22. *P. Cucurbitinum.*
23. *P. crassiusculum.*
24. *P. curtum.*

β. Cell-wall smooth.
25. *P. rufescens.*
26. *P. cruciferum.*
27. *P. inconspicuum.*

††† Cells elongated, up to 30 times longer than broad.
28. *P. minutum.*

Section A.

1. **Penium Libellula** (Focke) Nordst.

(Pl. VII, figs. 6, 7.)

Closterium Libellula Focke, Phys. Stud. 1847, p. 58, t. 3, f. 29.
Penium closterioides Ralfs, Brit. Desm. 1848, p. 152, t. 34, f. 4; Arch. in Pritch. Infus. 1861, p. 751; Rabenh. Flor. Europ. Alg. III, 1868, p. 121; Kirchn. Alg. Schles. 1878, p. 135; Wolle, Desm. U.S. 1884, p. 35, t. 5, f. 18; Cooke, Brit. Desm. 1886, p. 41, t. 16, f. 3; Nordst. Freshw. Alg. N. Zeal. 1888, p. 71; West, Alg. W. Ireland, 1892, p. 127; Alg. Eng. Lake Distr. 1892, p. 721; Börg. Ferskv. alg. Östgrönl. 1894, p. 9, t. 1, f. 1; Nordst. Index Desm. 1896, p. 75.
Closterium Lens Jacobs. (and var. *intermedia* Jacobs.) Desm. Danem. 1875, pp. 167 and 168.
Penium closterioides Ralfs, a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 24, t. 2, f. 2*f*.
Penium Libellula (Focke) Nordst. Bornh. Desm. 1888, p. 184; Turn. Freshw. Alg. E. India, 1893, p. 20; West & G. S. West, Alg. S. England, 1897, p. 479; Alg.-fl. Yorks. 1900, p. 45; Freshw. Alg. Ceylon, 1902, p. 135; Alg. N. Ireland, 1902, p. 21.

Cells large, 5–7 times longer than their diameter, unconstricted, fusiform, with rounded or more often with subtruncate poles; cell-wall smooth, often of a yellowish-brown colour; each chloroplast with about 8 longitudinal plates and 3–6 pyrenoids; apical vacuoles frequently present with several moving granules.

Zygospore globose and smooth.

Length 230–356 μ; breadth 36–52 μ; diam. zygosp. 45–56 μ.

England.—Cumberland! Westmoreland! (*Bissett*). W. and N. Yorks! Lancashire! Warwick (*Wills*). Sussex (*Ralfs*). Surrey! (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*).

Wales.—Capel Curig! (*Cooke & Wills*), Llyn Idwal!, Llyn-an-afon!, near Dolbadarn Castle!, Bettws-y-coed (*Roy*); Carnarvonshire! Llyn Coron, Anglesey!

Scotland.—Sutherland! Ross!, Inverness, Aberdeen, Kincardine, Forfar, Perth!, Argyll (*Roy & Bissett*). Ayr! General in the Outer Hebrides!

Ireland.—Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Donegal! Down!

Geogr. Distribution.—France. Germany. Italy.

Norway. Sweden. Austria. Hungary. Russia. Lapland. Faeroes. Greenland. Ceylon. Singapore. Java. Central China. New Zealand. Brazil.

This is a well-marked species with the aspect of a straight *Closterium*. Forms are sometimes met with in which there are two thickened bands round the centre of the cells; we give a figure of one of these forms from Capel Curig, N. Wales (Pl. VII, fig. 8). Gutwinski has described this form as *Closterium rectum* (*vide* Gutw. Nonn. Alg. Nov. 1896, p. 35, t. v, f. 3).

Lütkemüller is probably correct in considering *Penium Libellula* as a true species of *Closterium*. It is in a case of this kind that the distinction between *Penium* and *Closterium* completely breaks down.

Var. **interruptum** West & G. S. West. (Pl. VII, figs. 9, 10.)

Penium closterioides forma *interrupta* West, Alg. Eng. Lake Distr. 1892, p. 721; Schmidle, Beitr. Alg. Schwarzwald. 1893, p. 88, t. 3, f. 7.
P. Libellula var. *interruptum* West & G. S. West, Alg. S. England, 1897, p. 479; Desm. Singapore, 1897, p. 156; Freshw. Alg. Ceylon, 1902, p. 135.

Somewhat smaller than the typical form, with each chloroplast transversely divided, so that there are four axile chloroplasts in each cell arranged in a longitudinal series.

Length 122–240 μ; breadth 24–44 μ.

England.—Black Sail Pass, Cumberland! Loughrigg and Elter Water, Westmoreland! Chobham Common, Surrey!

Scotland.—Loch Doon, Ayr! Rhiconich, Sutherland!

Geogr. Distribution.—Germany. Ceylon. Singapore.

Var. **intermedium** Roy & Biss. (Pl. VII, fig. 11.)

P. Libellula var. *intermedium* Roy & Biss. Scott. Desm. 1894, p. 252. West & G. S. West, Desm. Singapore, 1897, p. 156; Alg. N. Ireland, 1902, p. 21; Freshw. Alg. Ceylon, 1902, p. 136.

Rather less than half the size of the typical form, but otherwise precisely similar.

Length 102–132 μ; breadth 19–29 μ.

England.—Westmoreland! Surrey! Cornwall!

WALES.—Bog above the Capel Curig lakes, and Llyn Idwal, Carnarvonshire!

SCOTLAND.—Ross, Inverness!, Aberdeen, Kincardine, Perth, Argyll, Arran (*Roy & Bissett*). Sutherland! Ayr!

IRELAND.—Sproule's Lough and near Lough Magrath, Donegal!

Geogr. Distribution.—Russia. Ceylon. Singapore.

This variety is probably far more widely distributed than is here indicated, as it has undoubtedly been overlooked in the past.

2. **Penium Navicula** Bréb.

(Pl. VII, figs. 12–15, and 19.)

Penium Navicula Bréb. Liste Desm. 1856, p. 146, t. 2, f. 37; Arch. in Pritch. Infus. 1861, p. 751; Rabenh. Flor. Europ. Alg. 1868, III, p. 121; Lund. Desm. Suec. 1871, p. 84, t. 5, f. 8; Kirchn. Alg. Schles. 1878, p. 135; Wolle, Desm. U.S. 1884, p. 36, t. 5, f. 16; Cooke, Brit. Desm. 1886, p. 42, t. 16, f. 5; Mask. Further Notes N. Zeal. Desm. 1889, p. 28, t. 5, f. 51 *a*; West, Alg. W. Ireland, 1892, p. 127; Alg. Eng. Lake Distr. 1892, p. 721; Roy & Biss. Scott. Desm. 1894, p. 252; West & G. S. West, Alg. S. England, 1897, p. 479; Alg. N. Ireland, 1902, p. 21; Alg.-fl. Yorks. 1900, p. 45.

Penium Berginii Arch. Suppl. Cat. in Dubl. Univers. Zool. Bot. Assoc. 1858, p. 121, t. 11, f. 14, 15.

Closterium Lens Jacobs. var. *minor* Jacobs. Desm. Danem. 1875, p. 168.

Penium closterioides Ralfs, b. *Navicula* Klebs, Desm. Ostpreuss. 1879, p. 24, t. 3, f. 2. *g*.

Cells small, 3½–5 times longer than their diameter, unconstricted, fusiform, with the poles broadly rounded; cell-wall smooth and colourless; each chloroplast with 5 or 6 longitudinal plates (or ridges) and 1 or 2 pyrenoids; apical vacuoles often present with two or three minute moving granules.

Zygospore subquadrate, compressed, with rather sharply produced angles to which the empty half-cells are attached.

Length 32–61 μ; breadth 10–15 μ; breadth of apices 6–7 μ; length of zygospore 38–43 μ; breadth of zygosp. 33–38 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*).

W., N., and E. Yorks! Lancashire! Cheshire (*Roy*). Leicester (*Roy*). Warwick (*Wills*). Essex! Kent! Surrey! Hants! Devon! Cornwall! (*Marquand*).

WALES.—General in Carnarvonshire and Merioneth!

SCOTLAND.—Common!; often with zygospores (*Roy & Bissett*). Common in the Outer Hebrides! Shetlands!

IRELAND.—General in Galway, Kerry, and Donegal! Dublin and Wicklow (*Archer*). Down!

Geogr. Distribution.—France. Germany. Austria. Hungary. Norway. Sweden. Italy. Russia. Lapland. Faeroes. Greenland. India. Ceylon. Singapore. United States. Brazil.

This is a widely distributed species, particularly in mountainous districts. Its small size and its outward form, which somewhat resembles certain species of *Navicula*, render it easy of identification.

Lütkemüller considers it to be a much-shortened, straight species of *Closterium*—*Cl. Navicula* (Bréb) Lütkem.—but there are equally good reasons for retaining the plant in the genus *Penium*.

Forma **Willei** Schmidle.

Penium Navicula Bréb. forma *apicibus rotundato-truncatis*. Wille, Norges Ferskv. Alg. 1880, p. 49, t. 2, f. 32; West, Alg. Eng. Lake Distr. 1892, p. 721.

P. Navicula forma *Willei* Schmidle, Lappmark Süsswasseralgen, 1898, p. 17.

A form with the apices subtruncate.

Length 41 μ; breadth 12 μ.

ENGLAND.—Bowness, Helvellyn, and Langdale, Westmoreland!

Geogr. Distribution.—Germany. Switzerland. Austrian Tyrol. Norway.

Var. **crassum** *var. nov.* (Pl. VII, figs. 16, 17.)

Cells about 3 times longer than their diameter, not so attenuated; apices very broad and rounded-truncate.

Length 36·5–48 μ; breadth 14·5–15·5 μ; breadth of apices 8·5–9·5 μ.

SCOTLAND.—Near Balallan, Lewis; and near Tarbert, Harris, Outer Hebrides!

So far as our own experience goes, this variety is confined to the extreme north-west of Scotland.

Var. **inflatum** *var. nov.* (Pl. VII, fig. 18.)

Somewhat larger than the typical form, 3 times longer than the diameter, elliptic-fusiform, in the median part of the cell subcylindrical; apices rounded.

Length 74 μ; breadth 24 μ.

SCOTLAND.—Ben Laoigh, Perthshire!

This variety is of the same outward form as the small forms of *P. Navicula* figured by Heimerl (Desm. alp. 1891, p. 590, t. 5, f. 2.) and erroneously ascribed by him to Wille's "forma *apicibus rotundato-truncatis*" (= forma *Willei* Schmidle). It also bears a great resemblance to another plant described by Heimerl (l. c. t. 5, f. 3) as *P. closteroides* Ralfs, forma *minor*, but it is relatively shorter and of smaller size. Schmidle has termed this second form of Heimerl's *P. Heimerlianum* (consult Schmidle, Alg. Bern. Alp. 1894, p. 89), but it is very difficult to define as a species distinct from *P. Navicula* and *P. Libellula* var. *intermedium*.

3. **Penium Jenneri** Ralfs.

(Pl. VII, figs. 20, 21.)

Penium Jenneri Ralfs, Brit. Desm. 1848, p. 153, t. 33, f. 2; Rabenh. Flor. Europ. Algar. III, 1868, p. 120; Wittr. Gotl. Öl. sötv. Alg. 1872, p. 67; Gay, Monogr. loc. Conj. 1884, p. 69; Wolle, Desm. U.S. 1884, p. 36; Racib. Desm. Nowe, 1889, p. 74; Nordst. Index Desmid. 1896, p. 150; West, Alg. W. Ireland, 1892, p. 128.

Penium Brébissonii var. *Jenneri* Kirchn. Alg. Schles. 1878, p. 136.

Cylindrocystis Brébissonii var. *Jenneri* Hansg. Prodr. Algenfl. Bömh. 1888, p. 175.

Cells small, 2–4 times longer than their diameter, unconstricted, cylindrical; apices broadly rounded; cell-wall smooth; chloroplasts axile.

Zygospore globose and smooth, becoming yellow-brown.

Length 20–58 μ; breadth 13–15 μ; diameter of zygospore 25–35 μ.

ENGLAND.—Tunbridge Wells, Sussex (*Jenner; Ralfs*). Sutton Park, Warwick (*Wills*).

SCOTLAND.—Several localities in Aberdeenshire (*Roy & Bissett*). Ben Nevis, Inverness! New Galloway, Kirkcudbright! Zygospores from Dinnet, Aberdeen (*Roy & Bissett*).

IRELAND.—Lakes near Recess, Galway!

Geogr. Distribution.—Germany. Austria. Norway. Sweden. Poland.

This Desmid requires investigation as the nature of its chloroplasts is unknown. Ralfs states: "I know no character by which to distinguish the usual state of *Penium Jenneri* from *P. Brébissonii*. They agree in size and form; in both the arrangement of the endochrome is similar." If the latter statement is correct the plant should be placed in the genus *Cylindrocystis*, but as we have never seen any living specimens we retain it in the genus *Penium*.

The conjugation, which takes place by the protrusion of conjugating-tubes, and the globular zygospore, indicate that it is a plant quite distinct from *Cylindrocystis Brébissonii*. Perhaps it would be better placed as *Cylindrocystis Jenneri* nob.

4. **Penium spinospermum** Josh.

(Pl. VIII, figs. 6, 7.)

Penium spinospermum Josh. Notes Brit. Desm. II, 1883, p. 292; New and rare Desm. 1885, p. 35, t. 254, f. 10; Cooke, Brit. Desm. 1886, p. 45, t. 17, f. 9; De Toni, Syll. Alg. 1889, p. 863; Nordst. Index Desmid. 1896, p. 237; West & G. S. West, Alga-fl. Yorks. 1900, p. 45.

Penium spinospermum forma *minor* West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 135, t. 18, f. 8, 9.

Cells small, 2–2¼ times longer than their diameter, unconstricted or with a very slight median constriction, very slightly attenuated towards the apices, which are rounded; cell-wall smooth.

Zygospore globose, covered with obtuse conical projections.

Length 25–30 *μ*; breadth 12·3–15·5 *μ*; diameter of zygospore with projections 26–33 *μ*.

ENGLAND.—Cowgill Wold Moss, Widdale Fell, W. Yorkshire (with zygospores)!

SCOTLAND.—Inverness, Aberdeen, Kincardine, Stirling, Argyll, Renfrew (*Roy & Bissett*).

IRELAND.—Derrystrasna Bog, Armagh. (*Joshua*). Mourne Mts., Down (with zygospores) !

Geogr. Distribution.—Ceylon.

Joshua's measurements for this species are quite wrong according to his own figures; we are therefore compelled to consider the "forma *minor*" as identical with the typical plant. It is a rare species with a very characteristic zygospore.

5. **Penium didymocarpum** Lund.

(Pl. VIII, figs. 11–13.)

Penium didymocarpum **Lund. Desm. Suec. 1871, p. 85, t. 5, f. 9; Cooke, Brit. Desm. 1886, p. 44, t. 17, f. 6; Nordst. Freshw. Alg. N. Zeal. 1888, p. 72 (formæ incertæ); West, Alg. Eng. Lake Distr. 1892, p. 721; Lütkem. Desm. Attersees, 1893, p. 545.**

Schizospora minor **Reinsch, Contrib. Alg. et Fung. 1875, p. 87, t. 17, f. 2.**

Schizospora didymocarpa **Hansg. Prodr. Algenfl. Böhm. 1888, p. 175 (note)**

Cells small, about 2½ times longer than their diameter, unconstricted, subcylindrical, slightly attenuated towards the poles, which are rounded; cell-wall smooth; each chloroplast with one pyrenoid.

Zygospore *double*, compressed, subquadrate with rounded angles, of which the exterior ones slightly project; empty semicells closely adhering to the exterior angles.

Length 31–38 μ; breadth 13–15·3 μ; length of zygospore 22–30 μ, breadth 31–38 μ.

ENGLAND.—Risley Bog (*Roy*); Hawkshead (with zygospores) !, Lancashire, Devon (*Bennett*). Cornwall (*Marquand*).

WALES.—Capel Curig, Carnarvonshire (*Roy*).

SCOTLAND.—General !; conjugation not uncommon (*Roy & Bissett*). Near Balallan, Lewis, and near Tarbert, Harris, Outer Hebrides (with zygospores) !

IRELAND.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Austria. Sweden. Denmark. Lapland. Central China. New Zealand.

This species is remarkable in the possession of a double zygospore, a phenomenon which normally exists in about four species of Desmids. There are two zygospores in close apposition, each one being formed by the union of a distinct pair of gametes. The *four* cells which take part in the conjugation appear to be produced from one individual by two consecutive vegetative divisions, and prior to conjugation they become enveloped in a copious mucus.

In the other Desmids in which a double zygospore results from conjugation only *two* cells are concerned in its formation.

The outer layers of the wall of the zygospore frequently show signs of splitting off, and for this reason Reinsch placed the plant in a genus which he named *Schizospora*.

6. **Penium Mooreanum** Arch.

(Pl. VIII, figs. 8–10.)

Penium Mooreanum Arch. Descript. New Cosm., etc. 1864, p. 24, t. 1, f. 34–44; Rabenh. Flor. Europ. Algar. III, 1868, p. 123; Cooke, Brit. Desm. 1886, p. 44, t. 17, f. 6; West, Alg. N. Yorks. 1889; Alg. W. Ireland, 1892, p. 128; West & G. S. West, Alga-fl. Yorks. 1900, p. 46; Schmidle Beitr. Alg. Schwarzwald. 1893, p. 88, t. 3, f. 8, 9.

Cells minute, $1\frac{1}{3}$–$1\frac{1}{2}$ times longer than their diameter, unconstricted, ellipsoid with truncately rounded apices; chloroplasts with four or five longitudinal ridges; cell-wall smooth.

Zygospore quadrangular-oblong, compressed, with the lateral margins hollow and the angles markedly mammillate.

Length 19 μ; breadth 12·7 μ; length of zygospore 35–42 μ, breadth 25 μ.

ENGLAND.—Kildwick and Howgill Fells, W. Yorks! Near Scarborough and Mickle Fell, N. Yorks. (with zygospores)!

WALES.—Bethesda and Glyder Fach (at 2,200 ft.), Carnarvonshire!

SCOTLAND.—Inverness, Aberdeen!, Kincardine, Forfar, Perth (*Roy & Bissett*). Dumfries! Kirkcudbright! Caithness! Shetlands!

IRELAND. — Galway! Kerry! Dublin (*Archer*). Down!

Geogr. Distribution.—Germany. Austria. Switzerland. Italy. Norway. Lapland.

Archer describes this species as sub-elliptic in outline, with the sides somewhat barrel-shaped and the ends truncato-rotund. He states that the zygospore is twisted in those instances in which the conjugating cells lie at right angles to each other.

7. **Penium suboctangulare** West.

(Pl. VIII, figs. 14–19.)

Penium suboctangulare West, Alg. W. Ireland, 1892, p. 128, t. 24, f. 20; West & G. S. West, Alg. S. England, 1897, p. 479; Nordst. Index Desmid. 1896, p. 246.

Cells minute, about 1½ times longer than their diameter, oblong-ellipsoid, unconstricted, apices broadly rounded; cell-wall smooth and colourless.

Zygospore quadrate or oblong, compressed; angles truncate and retuse; cell-wall thick, ultimately becoming brown.

Length 14–16 μ; breadth 10 μ; length of zygospore 25–28 μ, breadth 20–25 μ, thickness 18 μ.

ENGLAND.—New Forest, Hants. (with zygospores)!

IRELAND.—Lower Lake of Killarney, Kerry (with zygospores)!

8. **Penium minutissimum** Nordst.

(Pl. VIII, figs. 20–23.)

Penium minutissimum Nordst. Norges Desm. 1873, p. 43, t. 1, f. 21; Cooke, Brit. Desm. 1886, p. 45, t. 17, f. 10; West & G. S. West, Alg. Madag. 1895, p. 47; Nordst. Index Desmid. 1896, p. 171; West & G. S. West, Alga-fl. Yorks. 1900, p. 46.

Cells minute, 1½–2 times longer than their diameter, unconstricted or very slightly constricted in the middle, subellipsoid, very slightly but gradually attenuated from the middle towards the apices which are broadly rounded; cell-wall smooth, yellowish.

Zygospore subquadrate, angles rounded and slightly prominent; broadly elliptical from both vertical and lateral views; cell-wall yellowish.

Length 12–16 μ; breadth 9–10 μ; length of zygospore 16 μ, breadth 14 μ.

England.—Old Cote Moor, W. Yorks! Mickle Fell, N. Yorks!

Scotland.—Poolewe, Ross; Brin, Inverness: Heughhead, Aboyne, "Colonel's Bed" in Braemar, Aberdeen; zygospores from Aboyne, Aberdeen (*Roy & Bissett*). Lewis, Outer Hebrides!

Wales.—Capel Curig, Carnarvonshire! Ffestiniog, Merioneth!

Ireland.—Mourne Mts., Down!

Geogr. Distribution.—France. Austria. Norway. Burmah. Siam. Madagascar. Brazil. Argentina.

9. **Penium truncatum** Bréb.

(Pl. VIII, figs. 24–26.)

Penium truncatum Bréb. in Ralfs' Brit. Desm. 1848, p. 152, t. 25, f. 2; Arch. in Pritch. Infus. 1861, p. 751; Rabenh. Flor. Europ. Algar. III, 1868, p. 121; Kirchn. Alg. Schles. 1878, p. 136; Wolle, Desm. U.S. 1884, p. 35, t. 5, f. 9, 10; Cooke, Brit. Desm. 1886, p. 44, t. 17, f. 4; West, Alg. W. Ireland, 1892, p. 128; Alg. Eng. Lake Distr. 1892, p. 721; Roy & Biss. Scott. Desm. 1894, p. 253; West & G. S. West, Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1901, p. 46.; Alg. N. Ireland, 1902, p. 21; Nordst. Index Desmid. 1896, p. 261.

P. truncatum forma *punctata* West, Add. Alg. W. Yorks. II, 1891, p. 245; West & G. S. West, Alga-fl. Yorks. 1901, p. 46.

Cells small, 2–3 times longer than their diameter, cylindrical, slightly constricted or unconstricted, apices truncate with slightly rounded angles; cell-wall colourless and very minutely (often indistinctly) punctate.

Zygospore globose and smooth.

Length 23·5–47 μ; breadth 10–13·5 μ; diam. zygosp. 26·5 μ.

England.—W. and E. Yorks! Lancashire! Devon! Cornwall! (*Marquand*).

Wales.—Capel Curig! (*Cooke & Wills*), Llyn-y-cwm-ffynon, Llyn Idwal, Twll Du, Glyder Fach (at 2,200 ft.), Bethesda, Bettws-y-coed (*Roy*), Moelfre, Carnarvonshire! Dolgelly (*Ralfs*) and Ffestiniog, Merioneth! Glamorganshire! Monmouth!

Scotland.—Sutherland, Ross, Inverness! Aberdeen, Kincardine, Perth!, Argyll, Arran; zygospores from Muiryhaugh, Kincardine (*Roy & Bissett*).

IRELAND.—Kerry! Galway! Donegal! Dublin and Wicklow (*Archer*). Down! Antrim!

Geogr. Distribution.—France. Germany. Austria. Norway. Sweden. Italy. United States.

Ralfs believed this species to be minutely and indistinctly punctate, and we find the punctulations very variable in intensity; some forms are very distinctly punctate, but others are apparently quite smooth.

Section B.

10. **Penium margaritaceum** (Ehrenb.) Bréb.

(Pl. VIII, figs. 32–35.)

Closterium margaritaceum Ehrenb. Infus. 1838, p. 95, t. 6, f. xiii; Hass. Brit. Freshw. Alg. 1845, p. 376, t. 88, f. 5.

Penium margaritaceum (Ehrenb.) Bréb. in Ralfs' Brit. Desm. 1848, p. 149, t. 25, f. 1 *a, b, c*; t. 33, f. 3; Arch. in Pritch. Infus. 1861, p. 750, t. 2, f. 14, 15; Rabenh. Flor. Europ. Algar. III, 1868, p. 121; Kirchn. Alg. Schles. 1878, p. 135; Wolle, Desm. U.S. 1884, p. 34, t. 5, f. 5, 6, 11; Cooke, Brit. Desm. 1886, p. 38, t. 17, f. 1 *a–g*; West, Alg. W. Ireland, 1892, p. 126; Alg. Eng. Lake Distr. 1892, p. 720; Nordst. Index Desmid. 1896, p. 164; West & G. S. West, Alg. S. England, 1897, p. 478; Alga-fl. Yorks. 1901, p. 46; Alg. N. Ireland, 1902, p. 21; Roy & Biss. Scott. Desm. 1894, p. 252.

Cylindrocystis margaritacea Reinsch, Algenfl. Frank. 1867, p. 198.

? *Penium pandurans* De Not. Desm. Ital. 1867, p. 70, t. 8, f. 80.

Cells large, 6–12 times longer than their diameter, cylindrical or subfusiform, with a distinct median constriction, apices truncately rounded; cell-wall reddish-brown in colour and furnished with longitudinal rows of granules; chloroplast with about 10 longitudinal plates (or ridges) and often showing a slight median interruption.

Zygospore globose and smooth.

Length 73–170 μ; breadth 12·5–26 μ; breadth of apices about 7·5–18 μ; diam. zygosp. 47 μ.

ENGLAND.—Westmoreland! (*Bissett*). W. and N. Yorks! Lancashire! Cheshire (*Roy*). Warwick (*Wills*). Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*). Essex! (*Ralfs*).

WALES.—General, but scarce!

SCOTLAND.—Sutherland!, Ross, Inverness!, Aberdeen, Kincardine, Forfar, Perth!, Stirling, Arran (*Roy & Bissett*). Kirkcudbright! Harris, Outer Hebrides! Shetlands!

IRELAND.—Kylemore, Roundstone and Ballynahinch, Galway! Castletown and Carrantuohill, Kerry! Dublin and Wicklow (*Archer*). Slieve Donard, Down!

Geogr. Distribution.—France. Germany. Austria. Poland. Hungary. Italy. Portugal. Norway. Sweden. Finland. Lapland in Russia. Faeroes. Greenland. Spitzbergen. Java. New Zealand. East Africa. Azores. United States. Ecuador.

There is frequently a terminal vacuole at each extremity of the cell, containing moving granules.

11. **Penium Cylindrus** (Ehrenb.) Bréb.

(Pl. VI, figs. 1–3.)

Closterium ? (Toxotium) Cylindrus Ehrenb. Infus. 1838, p. 95, t. 6, f. vi; Menegh. Synops. Desm., 1840, p. 236.

Penium Cylindrus (Ehrenb.) Bréb. in Ralfs' Brit. Desm. 1848, p. 150, t. 25, f. 2; Arch. in Pritch. Infus. 1861, p. 750; Rabenh. Flor. Europ. Algar. III, 1868, p. 122; Cooke, Brit. Desm. 1886, p. 39, t. 17, f. 2; West, Alg. W. Ireland, 1892, p. 126; Alg. Eng. Lake Distr. 1892, p. 720; Roy and Biss. Scott. Desm. 1894, p. 251; Nordst. Index Desm. 1896, p. 96; West & G. S. West, Alg. S. England, 1897, p. 478; Alga-fl. Yorks, 1900, p. 44; Alg. N. Ireland, 1902, p. 21.

Dysphinctium Cylindrus Näg. Gatt. einz. Alg. 1849, p. 111; Hansg. Prodr. Algenfl. Böhm. 1888, p. 186.

Cylindrocystis Cylindrus Reinsch, Algenfl. Frank. 1867, p. 198.

Calocylindrus Cylindrus a. *genuinus* Kirchn. Alg. Schles. 1878, p. 142.

Calocylindrus Cylindrus b. *silesiacus* Kirchn. *l. c.*

Cells small, 2–4 (rarely up to 6) times longer than their diameter, cylindrical and unconstricted, apices truncately rounded; cell-wall reddish-brown in colour and furnished with longitudinal rows of minute granules, which are often scattered, especially near the extremities.

Zygospore globose and smooth.

Length 30–50 μ; breadth 10·5–14 μ; diam. zygosp. 25–27 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W. and N. Yorks! Lancashire! Warwick (*Wills*). Surrey (with zygospores, from Thursley Common)!

Sussex (*Ralfs*). Hants! (*Bennett*). Devon! Cornwall! (*Marquand*).

WALES.—General in the mountainous areas!

SCOTLAND.—General!; zygospores from north of Loch Dawan, Aberdeen (*Roy & Bissett*). Common in the Outer Hebrides!

IRELAND.—Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Down!

Geogr. Distribution.—France. Germany. Austria. Italy. Poland (var.). Switzerland. Norway. Sweden. Finland. Lapland in Russia. Faeroes. New Zealand. United States. Brazil.

12. **Penium cuticulare** West & G. S. West.

(Pl. VI, figs. 4, 5.)

Penium cuticulare West & G. S. West, New and Int. Freshw. Alg. 1896, p. 153, t. 4, f. 43, 44; Nordst. Index Desm. 1896, p. 276; West & G. S. West, Alg. S. England, 1897, p. 478; Notes Alg. I, 1898, p. 3 (sep.).

Cells minute, 2½–3½ times longer than their diameter. cylindrical and unconstricted, apices broadly truncate with rounded angles; cell-wall reddish-brown, very minutely and irregularly papillose-punctate.

Zygospore angular-globose, smooth.

Length 19–34 μ; breadth 8–10 μ; diam. zygosp. 19–22 μ.

ENGLAND.—Thursley Common, Surrey (with zygospores)!

This species is very closely allied to *P. cylindrus* (Ehrenb.) Bréb., differing only in its smaller size, the much finer and irregular markings on the cell-wall, and in the angularity of the zygospore. The young portions of the cell-wall are perfectly smooth and without colour.

It is a very similar plant to the one described by Schmidle as *P. Cylindrus* var. *subtruncatum* (*vide* Beitr. alp. Alg. 1895, p. 310, t. 14, f. 27, 28), but the latter is rather larger and has a colourless cell-wall. Schmidle (Lappmark Süsswasseralgen, 1898, p. 16) has since elevated his variety to specific rank under the name of *P. subtruncatum*, and he places *P. cuticulare* as a synonym of it. The two plants are, however, not strictly identical, and it is most probable that both should be merged into *P. Cylindrus.* It differs from *P. truncatum* Bréb in its cell-wall and in its less truncate apices. From the succeeding species—*P. exiguum* West—it is distinguished by its different proportions, by the absence of the median constriction, by the undilated apices, and by its cell-wall.

13. **Penium exiguum** West.

(Pl. VI, figs. 6, 7.)

Penium exiguum West, Alg. W. Ireland, 1892, p. 126, t. 19, f. 17, 18; Nordst. Index Desm. 1896, p. 121; West & G. S. West, Alg. N. Ireland, 1902, p. 21.

Cells small, 3–6 times longer than their diameter, cylindrical, usually with a slight median constriction, apices truncate and commonly slightly dilated; chloroplasts with 2–3 pyrenoids; cell-wall colourless, delicately and irregularly punctate.

Zygospore unknown.

Length 18·5–37 μ; breadth 6–8·5 μ.

SCOTLAND.—Near Balallan and near Barvas, Lewis; N. Uist, Outer Hebrides!

IRELAND.—Kylemore, Galway! Cromagloun, Kerry! Near Glenties; near Gweedore; pool near Lough Glentornan, Donegal!

This species is characterised by its relative proportions, its dilated apices, and its punctate cell-wall. There is frequently a terminal vacuole at each extremity of the cell, containing moving granules.

Forma **major** *nob.* (Pl. VI, fig. 8.)

Penium Lewisii Turner, Desm. Notes, 1893, p. 346, f. 15.
P. exiguum West, forma *Lewisii* West & G. S. West, Rec. publ. Desm. 1895, p. 66; Nordst. Index Desm. 1896, p. 122; West & G. S. West, Alg. S. England, 1897, p. 478; Alg. N. Ireland, 1902, p. 21.

Somewhat larger than the typical form, but otherwise exactly similar.

Length 46–62 μ; breadth 10–11 μ.

ENGLAND.—Keighley Moor, W. Yorks! Surrey! Cornwall!

WALES.—Llyn Idwal! Llyn-y-cwm-ffynon!, Snowdon (*Turner*), Carnarvonshire!

SCOTLAND. — Rhiconich, Sutherland! Lochnagar, Aberdeen (at 3,500 ft.)!

IRELAND.—Near Glenties, Donegal! Slievecommedagh, Down!

Geogr. Distribution.—Germany. Austrian Tyrol.

14. **Penium granulatum** (Benn.) *nob.*

(Pl. VIII, fig. 39.)

Docidium granulatum Benn. Alg. N. Cornwall, 1887, p. 15, t. 4, f. 17; Cooke, Brit. Desm. 1887, p. 184, t. 65, f. 2; Nordst. Index Desm. 1896, p. 134.

Cells small, about 5 times larger than their diameter, slightly constricted in the middle, semicells oblong-ellipsoid with the apices broadly rounded; cell-wall "conspicuously covered with pearly granules."

Length 50 μ; breadth 10 μ.

ENGLAND.—Mawgan, Cornwall (*A. W. Bennett*).

15. **Penium Clevei** Lund.

(Pl. VIII, figs. 36, 37.)

Penium Clevei Lund. Desm. Suec. 1871, p. 86, t. 5, f. 11; West, Alg. W. Ireland, 1892, p. 129; Alg. Eng. Lake Distr. 1892, p. 721; Nordst. Index Desm. 1896, p. 74; West & G. S. West, Some Desm. U. S. 1898, p. 281.

Penium Thwaitesii Cleve (*non* Ralfs).

Calocylindrus Clevei Wolle, Desm. U. S. 1884, p. 56, t. 50, f. 27.

Dysphinctium Clevei De Toni, Syll. Alg. 1889, p. 893.

Cells of medium size, 2½–3 times longer than their diameter, subcylindrical, slightly constricted in the middle; semicells pyramidate-ovate, with rounded apices; chloroplasts with one pyrenoid (rarely with two); cell-wall finely punctate and at each pole finely granulate.

Zygospore unknown.

Length 96–108 μ; breadth 36-42 μ; breadth of isthmus 33–38 μ.

ENGLAND.—Borrowdale and Angle Tarn, Cumberland! Bowness, Westmoreland!

SCOTLAND.—New Galloway, Kirkcudbright!

IRELAND.—Roundstone and Ballynahinch, Galway! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Austria. Lapland in Russia. East Africa. United States.

The finely granular apices of this species are very characteristic. It is a rare Desmid chiefly confined to a few permanent bogs.

Var. **crassum** West & G. S. West. (Pl. VIII, fig. 38.)

Penium Clevei var. *crassum* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 4, t. 1, f. 5; Nordst. Index Desm. 1896, p. 75.

Cells only twice longer than their diameter, with the lateral margins more convex and with smaller granules at the poles; chloroplast with one large pyrenoid.

Length 80–98 μ; breadth 42–44·5 μ; breadth of isthmus 39·5–40 μ.

ENGLAND.—Bog at the side of Angle Tarn, Cumberland (1,500 ft.)!

16. **Penium spirostriolatum** Barker.

(Pl. IX, figs. 1–8.)

? *Penium margaritaceum* var. γ *punctatum* Ralfs, Brit. Desm. 1848, p. 149, t. 25, f. 1 *d–h*; Schmidle, Beitr. Alg. Schwarzwald. 1893, p. 87, t. 3, f. 4.

Penium spirostriolatum Barker, in Quart. Journ. Micr. Sci. 1869, ix, p. 194; Arch. in Journ. Bot. 1874, p. 94; Cooke, Brit. Desm. 1886, p. 39, t. 15, f. 9; Wolle, Freshw. Alg. U.S. 1887, p. 22, t. 61, f. 19; West, Alg. N. Wales, 1890, p. 285, t. 6, f. 24; Alg. W. Ireland, 1892, p. 126; Alg. Engl. Lake Distr. 1892, p. 720; Roy & Biss. Scott. Desm. 1894, p. 253; West & G. S. West, Alg. S. England, 1897, p. 478; Some Desm. U.S. 1898, p. 282; G. S. West, Variation Desm. 1899, pp. 377-380; West & G. S. West, Alga-fl. Yorks. 1900, p. 46; Alg. N. Ireland, 1902, p. 21; Freshw. Alg. Ceylon, 1902, p. 136.

Closterium spiraliferum Jacobs. Desm. Danem. 1875, p. 177, t. 7, f. 8.

Penium Haynaldii Schaarschm. Magyar. Desm. 1883, p. 277, t. 1, f. 20.

Penium Royanum Turn. Freshw. Alg. of E. India, 1893, p. 165, t. 23, f. 7.

Penium scandinavicum Turn. l. c. p. 166, t. 23, f. 6.

Penium spirostriolatum var. *amplificatum* Schmidt, Grundl. Algenfl. Lüneburg. Heide, 1903, p. 16, t. 2, f. 19.

Cells large, 5–11 times longer than their diameter, subcylindrical, with a slight median constriction, gradually attenuated towards the apices, which are rounded or truncately rounded and sometimes dilated; transverse sutures usually several or many (16 have been observed), marking the junction of cylindrical interpolated pieces of cell-wall of various ages; cell-wall pale yellow or yellow-brown in colour, furnished with longitudinal striæ which have a variable spiral twist; striæ sometimes anastomosing or often partly replaced by rows of dots; between the striæ finely punctate.

Zygospore globose and smooth.

Length 123–274 μ; breadth 20–26 μ; breadth of apices 13·5–16 μ.

England.—Cumberland! Westmoreland! W. and N. Yorks! Lancashire! Surrey! Cornwall!

Wales.—General in Carnarvonshire! Ffestiniog, Merioneth!

Scotland.—Ross, Inverness!, Aberdeen, Kincardine, Perth!, Dumbarton, Argyll (*Roy & Bissett*). Sutherland! Lewis and Harris, Outer Hebrides!

Ireland.—General in Mayo! Galway! Kerry! Donegal! Armagh! Down!

Geogr. Distribution.—France. Germany. Austria. Hungary. Portugal. Denmark. Norway. Sweden. Finland. Ceylon. Java. United States.

The structure of the cell-wall of this Desmid has been carefully investigated (*vide* G. S. West, Variation Desm. 1899, pp. 377–380) and its striolation has been shown to be its most variable character. The striæ may be coarse, fine, or broken up into series of dots, even in different individuals from the same gathering, thus exhibiting the main characters of the three forms described by Turner as *Penium spirostriolatum, P. Royanum,* and *P. scandinavicum.* The number seen at one time across the cell varies from about 8 to 13, and this variation may be seen on one individual, the striolations being more crowded at some parts of the cell-wall than at others. In one individual two striolations were observed to be 2·3 μ apart, and the distance between one of these and the next one was 5·2 μ. They are generally arranged around the cell in a spiral manner from apex to apex, and may make about 1¼ turns in the whole length of the cell; but in the majority of specimens they are much straighter than this, and in some are longitudinal although not quite straight. They are not always continuous from end to end, but often run only part of the distance and then fade away or join with a neighbouring striolation. In many cases they are very irregular, and a reticulation is often present joining together several, or all of them. In some individuals this reticulation is concentrated in the middle of the cell; in others there is a marked reticulation at the end of the cell, and sometimes a reticulated zone is present just below the apex. Most specimens have a distinct convex apical cap which is strongly punctate, the punctulations being continuous with those between the striolations. All examples possess punctulations between the striolations, however minute they may be. There is every indication that the striolations are internal thickenings of the cell-wall. In the majority of instances the edges of the striolations are not smooth, but exhibit various degrees of roughness, and in some specimens under a particular focus a reticulation is perceived to exist between the punctulations, apparently connecting the striolations together.

The variations in the outward form of this species are due to the irregularity in the position of the sutures.

There is no doubt whatever that Ralfs confused this plant with *Penium margaritaceum*, and he unquestionably described and figured both vegetative specimens and zygospores under the name of "*P. margaritaceum* γ *punctatum*." It was one of the first Desmids we observed when examining some material of our own collecting from one of the favourite localities of Ralfs near Penzance.

17. **Penium polymorphum** Perty.

(Pl. IX, figs. 9–11.)

Closterium polymorphum **Perty, 1849.**

Penium polymorphum **Perty, Kleinst. Lebensf. 1852, p. 207, t. 16. f. 15; Rabenh. Flor. Europ. Algar. III, 1868, p. 123 (in part); Lund. Desm. Suec. 1871, p. 86, t. 5, f. 10; Wolle, Desm. U. S. 1884, p. 36, t. 5, f. 12; Nordst. Freshw. Alg. N. Zeal. 1888, p. 71; West, Alg. W. Ireland, 1892, p. 128; Alg. Engl. Lake Distr. 1892, p. 721; Roy & Biss, Scott. Desm. 1894, p. 253; Nordst. Index Desm. 1896, p. 203; West & G. S. West, Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 46; Alg. N. Ireland, 1902, p. 22.**

Cosmarium polymorphum **Jacobs. Desm. Danem. 1876, p. 201.**

Penium polymorphum **forma *alpicola* Heimerl, Desm. alp. 1891, p. 590, t. 5, f. 4.**

Penium polymorphum **var. *Lundellii* Schmidle, Alg. Bern. Alp. 1894, p. 89.**

Cells small, 2–2½ times longer than their diameter, cylindrical or subcylindrical, with a very slight median constriction; semicells commonly gradually but very slightly attenuated to the apices, which are broad and truncately rounded; cell-wall with very delicate longitudinal striolations; chloroplasts with one large pyrenoid and many longitudinal ridges.

Zygospore unknown.

Length 44–61 μ; breadth 21–28 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). Common in the upland districts of Yorks. (up to 2,000 ft.)! Surrey! Cornwall!

WALES.—Penmaenmawr, Y Foel Fras, Llyn Idwal, Llyn Bochlwyd, Glyder Fawr (at 2,700 ft.), Llyn-y-cum-ffynon, and Snowdon, Carnarvonshire!

SCOTLAND.—Sutherland!, Ross, Inverness!, Aberdeen!, Kincardine, Forfar!, Perth!, Stirling, Argyll, Arran (*Roy & Bissett*). Lewis, Harris, and Benbecula, Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Galway! Kerry! Donegal! Shores of Lough Neagh! Londonderry! Down! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Switzerland. Lapland in Russia. India (forma). New Zealand. Azores (var.) United States.

This species is somewhat variable, but we see no reason for giving the name "var. *Lundellii*" to the most abundant form of it.

18. **Penium phymatosporum** Nordst.

(Pl. VI, figs. 9–11.)

Penium phymatosporum Nordst. Desm. Ital. 1876, p. 26, t. 12, f. 1; Josh. New and Rare Desm. 1885, p. 35, t. 254, f. 11; Cooke, Brit. Desm. 1886, p. 40, t. 17, f. 8.

Cells small, about 2¼ times longer than their diameter, subcylindrical, unconstricted or with a very slight median constriction, very gradually and very slightly attenuated towards the apices, which are truncately rounded; cell-wall with very delicate longitudinal striolations; chloroplasts with one pyrenoid.

Zygospore subquadrate or rectangular, with the angles obtuse and protruding; apices and sides concave, with a rounded protuberance on each side and four similar ones within the angles; side view of zygospore sexangular; cell-wall thick.

Length 26–42 μ; breadth 11–18 μ; length of zygosp. 36–42 μ; breadth of zygosp. 30–36 μ.

ENGLAND.—Minety, Wilts (with zygospores; *Joshua*).

SCOTLAND.—Near Mill of Muchalls, Kincardine (with zygospores; *Roy & Bissett*).

IRELAND.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Austria. Italy. Argentina. Trinidad (?).

This species is characterised by its delicately striated cells and its peculiar zygospore.

19. **Penium subtile** West & G. S. West.

(Pl. VIII, figs. 27–29.)

Penium subtile **West & G. S. West, Alg. S. England, 1897, p. 479, t. 6, f. 8, 9.**

Cells very minute, almost 1½ times longer than their diameter, ellipsoid with a very faint median constriction (often only indicated by a median suture), apices subtruncate; cell-wall colourless, very delicately and indistinctly punctulate; punctulations scattered, about 12 in each semicell; chloroplasts with one pyrenoid, and with two, three, or four longitudinal ridges; sometimes with only one chloroplast situated in the median portion of the cell.

Zygospore unknown.

Length 14–15 μ; breadth 10–11 μ.

ENGLAND.—Thursley Common, Surrey!

WALES.—Llyn Geirionedd, Carnarvonshire!

SCOTLAND.—Near Balallan, Lewis; and a pure gathering from S. Harris, Outer Hebrides!

This is a rare species which occasionally occurs in prodigious quantity in small pools in the best bogs of the country. The widest part of the cell is always in the middle, and the apices are always flattened. Most specimens have two chloroplasts situated close together in the middle region of the cell, and each furnished with a pyrenoid, but others have only one median chloroplast with one pyrenoid. The frequent reduction of the longitudinal ridges to two is also noteworthy. This same reduction of the chloroplasts we have observed in *Cosmocladium constrictum* Arch.

P. subtile can be compared with *Dysphinctium sparsipunctatum* Schmidle, from the unconstricted form of which it differs in the shape of its cells, its much more delicate punctulations, and its circular vertical view.

20. **Penium adelochondrum** Elfv.

(Pl. VIII, figs. 30, 31.)

Penium adelochondrum Elfv. Anteck Finska. Desm. 1881, p. 17, t. 1, f. 13; West, Alg. W. Ireland, 1892, p. 128; Roy & Biss. Scott. Desm. 1894, p. 251; Nordst. Index Desm. 1896, p. 40.

Cells small, 2½–2¾ times longer than their diameter, subcylindrical, gradually narrowed towards each pole, with a slight median constriction, apices broadly truncate; cell-wall somewhat sparsely scrobiculate.

Zygospore unknown.

Length 40–46 μ; breadth 16–20 μ; breadth of apices 10–12·5 μ.

SCOTLAND.—Poolewe, Ross; Glen Sligachan in Skye, Inverness; Glen Cattie, Aberdeen (*Roy & Bissett*). Rhiconich, Sutherland!

IRELAND.—Cromagloun and Torc Mt., Kerry!

Geogr. Distribution.—Germany. Austria. Finland. West Africa.

21. **Penium lagenarioides** Roy.

(Pl. IX, fig. 12.)

Penium lagenarioides Roy, in Biss. Desm. Windermere, 1884, p. 197, t. 5, f. 6; Cooke, Brit. Desm. 1886, p. 45; Roy & Biss. Scott. Desm. 1894, p. 252; Nordst. Index Desm. 1896, p. 154.

Cells large, ellipsoid, about twice longer than their diameter, with a very slight median constriction, semicells gradually attenuated towards the apices, which are subtruncate and slightly thickened; cell-wall regularly and somewhat sparsely punctate; chloroplasts with 9 or 10 longitudinal plates (or ridges) and one large pyrenoid.

Zygospore unknown.

Length 92–95 μ; breadth 45 μ.

ENGLAND.—Near Bowness, Westmoreland (*Bissett*).

SCOTLAND.—Near Tain, Ross; Slewdrum, Aboyne, Dawan, Presswhin, Dalbagie, Glen Clunie, Aberdeen; Scolty Dam, Curran, Bishop's Dam, Kincardine; Glen Clova, Glen Dole, Forfar; Brecklin, Coilantogle, Perth (*Roy & Bissett*).

Geogr. Distribution.—Java (var.).

22. **Penium cucurbitinum** Biss.

(Pl. IX, figs. 13, 14.)

Penium cucurbitinum Biss. Desm. Windermere, 1884, p. 197, t. 5, f. 7; Cooke, Brit. Desm. 1886, p. 46; West, Alg. N. Yorks. 1889, p. 291; Alg. N. Wales, 1890, p. 286; Alg. W. Ireland, 1892, p. 128; Alg. Eng. Lake Distr. 1892, p. 721; Roy & Biss. Scott. Desm. 1894, p. 251; Nordst. Index Desm. 1896, p. 92; West & G. S. West, Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 47.

Cells of medium size, subcylindrical, rather more than 2½ times longer than their diameter, slightly tapering towards the apices which are broadly rounded, with a slight median constriction; cell-wall minutely and somewhat sparsely punctate; chloroplasts with about six longitudinal ridges and one large pyrenoid.

Zygospore unknown.

Length 64–83 μ (rarely up to 90 μ); breadth 26–33 μ (rarely up to 35 μ).

ENGLAND.—Near Bowness! (*Bissett*), Loughrigg!, Helvellyn!, trough at Ambleside, Westmoreland! Ogden Clough, Shipley Glen, Holden Ghyll near Keighley, Ilkley, Penyghent, Widdale Fell, W. Yorks! Riccall Common, E. Yorks! Epping Forest, Essex! Thursley Common, Surrey!

WALES.—Llyn-an-afon, Y Foel Fras, and Snowdon, Carnarvonshire!

SCOTLAND.—Sutherland!, Ross!, Aberdeen, Kincardine, Forfar!, Perth!, Argyll, Renfrew (*Roy & Bissett*). Ayr! Kirkcudbright! Harris, Outer Hebrides!

IRELAND.—Lakes near Recess and Ballynahinch, Galway! Castletown and Carrantuohill, Kerry!

Forma **minor** West & G. S. West. (Pl. IX, fig. 16.)

Penium cucurbitinum **forma** ***minor*** **West & G. S. West, New Brit. Freshw. Alg. 1894, p. 4; Roy & Biss. Scott. Desm. 1894, p. 251.**

Rather smaller than the average: length 50–58 μ; breadth 22·5–25 μ.

SCOTLAND.—Craig-an-Lochan, Perthshire!

Geogr. Distribution.—Siam. Brazil.

Forma **major** *forma nov.* (Pl. IX, fig. 17.)

Rather larger than the average: length 98–100 μ; breadth 34·5–37 μ.

SCOTLAND.—Tarbert, Harris; Near Balallan, Lewis, Outer Hebrides!

Var. **subpolymorphum** Nordst. (Pl. IX, figs. 19, 20.)

Penium cucurbitinum **var.** ***subpolymorphum*** **Nordst. Freshw. Alg. N. Zeal. 1888, p. 71, t. 7, f. 20; West, Alg. N. Yorks. 1889, p. 291; Mask. Further Notes N. Zeal. Desm. 1889, p. 27, t. 5, f. 50; Lütkem. Desm. Attersees, 1893, p. 544; West & G. S. West, Alga-fl. Yorks. 1900, p. 47.**

More attenuated towards the apices than the typical form; apices subtruncately rounded; cell-wall densely and minutely punctate.

Zygospore quadrate with rounded angles and straight sides; cell-wall lamellose.

Length 71–86 μ; breadth 32·5–38 μ; breadth of isthmus 32–35 μ; breadth of zygosp. 60–70 μ.

ENGLAND.—Mickle Fell, N. Yorks!

Geogr. Distribution.—Austria. New Zealand.

Lütkemüller's Austrian specimens of this variety were larger than either the English or New Zealand ones; he gives as his measurements: length 96–100 μ; breadth 40–42 μ; breadth of constriction 36 μ.

Var. **Scoticum** *nob.* (Pl. IX, fig. 18.)

Cosmarium Thwaitesii Ralfs, var. *Scoticum* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 8, t. 1, f. 15; Roy & Biss. Scott. Desm. 1894, p. 256; Nordst. Index Desm. 1896, p. 255.

Rather larger than the typical form, with the semicells inflated.

Length 95–97 μ; breadth 42·5–43·5 μ; breadth of constriction 36–37·5 μ.

SCOTLAND.—New Galloway, Kirkcudbright!

Intermediate forms are sometimes met with between this variety and the type. Such a form with slightly inflated sides we have observed from Widdale Fell, W. Yorks. (Pl. IX, fig. 15).

23. **Penium crassiusculum** De Bary.

(Pl. VIII, figs. 4, 5.)

Penium crassiusculum De Bary, Conj. 1858, p. 73, t. 5, f. 5–7; Cooke, Brit. Desm. 1886, p. 44, t. 17, f. 7; Roy & Biss. Scott. Desm. 1894, p. 251; Nordst. Index Desm. 1896, p. 86; Desm. Singapore, 1897, p. 157; West & G. S. West, Alga-fl. Yorks. 1900, p. 47; Alg. N. Ireland, 1902, p. 22.

Cells rather small, 3–3½ times longer than their diameter, cylindrical with parallel sides, with a distinct median constriction, apices truncate with the angles slightly rounded; cell-wall smooth and colourless; chloroplasts with 4 or 5 somewhat irregular longitudinal ridges.

Zygospore "similar to that of *P. phymatosporum*, but the angles less prominent and more rounded" (*Roy*).

Length 57–70 μ; breadth 20–23 μ; breadth of isthmus 18–18·5 μ.

ENGLAND.—Cowgill Wold Moss, Widdale Fell, W. Yorks!

SCOTLAND.—Not uncommon; zygospore from Kyles of Bute in Argyll (*Roy & Bissett*). Rhiconich, Sutherland!

IRELAND.—Near Lough Glentornan, Donegal! Lough Fea, Londonderry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Germany. Austria. Switzerland. Bornholm. Faeroes. Singapore. Java. Central China. Brazil.

This species is readily distinguished from *P. polymorphum* by its more cylindrical cells with more truncate apices. The median constriction is also more evident in *P. crassiusculum* and the cell-wall is smooth. The chloroplasts have also fewer and more irregular longitudinal ridges. It is a much rarer species than *P. polymorphum*, and one which we have never seen in quantity.

24. **Penium curtum** Bréb.

(Pl. X, figs. 21, 22.)

Closterium curtum Bréb, 1838.

Cosmarium curtum Ralfs, Brit. Desm. 1848, p. 109, t. 32, f. 9; Bréb. Liste Desm. 1856, p. 133; Arch. in Pritch. Infus. 1861, p. 735; Rabenh. Flor. Europ. Algar. III, 1868, p. 176.

Penium curtum Bréb. in Kütz. Spec. Alg. 1849, p. 167; Nordst. Desm. Spetsb. 1872, p. 25; Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 56, t. 14, f. 74; Wille, Norges Ferskv. Alg. 1880, p. 49; Racib. Desmidyja Ciastonia, 1892, p. 390; West, Alg. Eng. Lake Distr. 1892, p. 721; Roy & Biss. Scott. Desm. 1894, p. 251; Nordst. Index Desm. 1896, p. 93; West & G. S. West, Alg. Madag. 1895, p. 47; Alg. S. England, 1897, p. 479; Welw. Afric. Freshw. Alg. 1897, p. 77; Furth. Contrib. Freshw. Alg. W. Indies, 1899, p. 283; Alga-fl. Yorks. 1900, p. 47; Alg. N. Ireland, 1902, p. 22.

Dysphinctium ? curtum Näg. Gatt. einz. Alg. 1849, p. 112; Reinsch Algenfl. Frank, 1867, p. 178.

Dysphinctium (*Actinotænium*) *Regelianum* Näg. l. c. p. 110, t. VI E.

Calocylindrus curtus Kirchn. Alg. Schles. 1878, p. 143; Wolle, Desm. U. S. 1884, p. 54, t. 12, f. 15, 16; Cooke, Brit. Desm. 1886, p. 126, t. 43, f. 11.

Cosmarium Thwaitesii d. *curtum* Klebs, Desm. Ostpreuss. 1879, p. 27.

Cells small, sometimes minute, a little more than twice longer than their diameter, with a distinct median constriction; semicells attenuated, sides convex, apex rounded and sometimes slightly thickened; cell-wall punctate; chloroplasts with about eight longitudinal ridges.

Zygospore unknown.

Length 22–60 µ; breadth 10·5–32·5 µ; breadth of isthmus 9·5–30 µ.

ENGLAND.—Westmoreland! W. and N. Yorks! Lancashire! Leicester (*Roy*). Gloucester! (*Ralfs*). Surrey! Devon! Cornwall! (*Ralfs*).

WALES.—Capel Curig, Llyn Cwlyd, Bethesda, Carnarvonshire! Ffestiniog, Merioneth!

SCOTLAND.—Aberdeen, Kincardine, Perth! (*Roy & Bissett*). Skye in Inverness! Forfar! Kirkcudbright! Harris, Outer Hebrides! Shetlands!

IRELAND.—Dublin and Wicklow (*Archer*). Slievecommedagh, Down!

Geogr. Distribution.—France. Germany. Austria. Italy. Norway. Sweden. Greenland. Spitzbergen. Nova Zembla. Franz-Joseph Land. India. Burmah. Siam. West Africa. Madagascar. West Indies. United States.

This Desmid varies much in size within certain limits. There is no definite line of demarcation between any of these forms, every intermediate size being met with, but for convenience they may be classified as follows:—

(1) Forma **minuta** West.

Penium curtum forma *minuta* West, Alg. Eng. Lake Distr. 1892, p. 721.

Length 22–25 μ; breadth 10·5–11·5 μ.

(2) Forma **minor** Wille. (Pl. X, fig. 23.)

Penium curtum forma *minor* Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 56, t. 14, f. 75.

Dysphinctium curtum var. *exiguum* Hansg. in Oesterr. bot. Zeitschr. 1887, xxxvii, p. 57; Prodr. Algenfl. Böhm. 1888, p. 184.

Length 28–32 μ; breadth 12–17 μ.

(3) Forma **intermedia** Wille.

P. curtum forma *intermedia* Wille, l. c. f. 74.

Length 34–38 μ; breadth 16–19 μ.

(4) Forma **major** Wille. (Pl. X, figs. 24, 25.)

P. curtum forma *major* Wille, l. c. f. 73.

Length 42–60 μ; breadth 20–32·5 μ.

Penium curtum is a well-marked species by reason of its short cells with attenuated semicells. It is principally an upland Desmid, occurring amongst *Sphagnum* and amongst wet mosses on rocks. It sometimes occurs in pure masses in temporary pools of rain-water on road-sides, in cart-ruts, etc.

Var. **obtusum** West & G. S. West. (Pl. 10, fig. 26.)

Penium curtum var. *obtusum* West & G. S. West, Notes Alg. II, 1900, p. 289, t. 412, f. 1, 2; Alga-fl. Yorks. 1900, p. 47.

Rather larger than the average size, with the sides at the base of the semicells subparallel and with subtruncate apices, below which the sides are very faintly hollowed.

Length 41–45 μ; breadth 20–23 μ; breadth of isthmus 19 μ.

England.—Ingleton, W. Yorks!

25. **Penium rufescens** Cleve.

(Pl. VI, figs. 12, 13.)

Penium rufescens Cleve, Sverig. Desm. 1864, p. 493, t. 4, f. 5; Rabenh. Flor. Europ. Algar. III, 1868, p. 123; Lund. Desm. Suec. 1871, p. 85; Wille, Norges Ferskv. Alg. 1880, p. 50; Roy & Biss. Scott. Desm. 1894, p. 253; Nordst. Index Desm. 1896, p. 227; West & G. S. West, Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 44.

Penium rufopellitum Roy, Desm. Perthshire, 1877, p. 73; Cooke, Brit. Desm. 1887, p. 185; West, Alg. W. Ireland, 1892, p. 126.

Cells rather under the medium size, 2–2½ times longer than their diameter, cylindrical or very slightly widening from the middle to the rounded apices, with an exceedingly faint trace of a constriction in the middle; cell-wall dark brown or brick-red in colour, very minutely punctate; the newer portions of the cell-wall smooth and colourless, sometimes separating from the old coloured portions; chloroplasts with many longitudinal ridges.

Zygospore unknown.

Length 60–72 μ; breadth 23·5–29 μ.

England.—Bisley Common, Surrey! Cronkley Fell, N. Yorks!

Scotland.—Inverness, Aberdeen, Kincardine, Perth, Argyll (*Roy & Bissett*). Loch Luichart, Ross!

Ireland.—Kylemore, Galway!

Geogr. Distribution.—Norway. Sweden. Brazil.

In some specimens of this rare species the cell-wall is conspicuously punctate, but in others it is not.

26. **Penium cruciferum** (De Bary) Wittr.

(Pl. X, figs. 18, 19.)

Cosmarium ? cruciferum De Bary, Conj. 1858, p. 72, t. 7 G, f. 3-6; Arch. in Pritch. Infus. 1861, p. 735; Rabenh. Flor. Europ. Algar. III, 1868, p. 177; Lund. Desm. Suec. 1871, p. 51; Roy & Biss. Scott. Desm. 1894, p. 44.

Penium cruciferum (De Bary) Wittr. in Wittr. & Nordst. Alg. Exsicc. 1882, No. 482, and in fasc. 21 (1889), p. 48; Nordst. Freshw. Alg. N. Zealand, 1888, p. 71, t. 7, f. 19; Nordst. Index Desm. 1896, p. 90; West & G. S. West, Alg. S. England, 1897, p. 479; G. S. West, Alga-fl. Cambs. 1899, p. 111; West & G. S. West, Alga-fl. Yorks. 1900, p. 47.

Dysphinctium cruciferum Hansg. Prodr. Algenfl. Böhm. 1888, p. 185.

Cells small, about twice longer than their diameter, ellipsoid-subcylindrical with a slight median constriction, apices broadly rounded or truncately rounded; cell-wall smooth and colourless; chloroplasts with four longitudinal ridges and one central pyrenoid.

Zygospore unknown.

Length 15·3–26 μ; breadth 7·6–13·5 μ.

England.—Ogden Clough, Keighley Moor, Eldwick, Baildon Moor, Lindley, Appletreewick, Cocket Moss, Old Cote Moor, and Cray Moss, W. Yorks! Market Weighton, E. Yorks! Chippenham Fen, Cambridge! Epping Forest, Essex! Wimbledon Common, Surrey! Near St. Just, Cornwall!

Wales.—Llyn Ogwen and Llyn-cwm-ffynon, Carnarvonshire!

Scotland.—Near Loch Rosque, Ross! Lochnagar, Aberdeen; Durris, Kincardine; Rannoch, Perth! (*Roy & Bissett*). Near Loch Thom, Renfrew! Loch Dungeon, Kirkcudbright!

Ireland.—Loughs Anna, Gatny, and Machugh, Donegal! Slieve Donard, Down!

Geogr. Distribution.—France. Galicia in Austria. Lapland. New Zealand. East Africa. United States. Cuba.

This plant was doubtfully placed by its describer under the genus *Cosmarium*, but the structure of the chloroplasts and the very slight median constriction indicate a much closer relationship to the genus *Penium*. Moreover, Wittrock has described a variety of it (var. *pluriradians*) from Sweden in which there are five or six longitudinal ridges on each chloroplast. The normal number of ridges is four, and it is from this character as seen in the vertical view that the specific name is derived.

27. **Penium inconspicuum** West.

(Pl. X, figs. 15–17.)

Penium inconspicuum West, New Brit. Freshw. Alg. 1894, p. 4, t. 1, f. 6, 7; Nordst. Index Desm. 1896, p. 144; West & G. S. West, Some N. Amer. Desm. 1896, p. 237; Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 48; Lütkem. Desm. Millstättersees, 1900, p. 6 (sep.); West & G. S. West, Alg. N. Ireland, 1902, p. 22; Freshw. Alg. Ceylon, 1902, p. 135.

Cells very minute, about 3 times longer than their diameter, subcylindrical, slightly and gradually (but distinctly) constricted in the middle, gradually narrowed towards the apices, which are subtruncate; cell-wall smooth and colourless.

Zygospore unknown.

Length 15–19 μ; breadth 4·8–5·8 μ.

England.—Elter Water, Westmoreland! Pilmoor, N. Yorks! Riccall Common, E. Yorks! Keston Common, Kent! Puttenham Common, Surrey!

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Near Callernish and near Balallan, Lewis, Outer Hebrides!

Ireland.—Lough Gartan, Donegal!

Geogr. Distribution.—Austria. Ceylon. Siam. United States.

This is one of the smallest and most characteristic species of the genus, but owing to its size it is readily overlooked.

28. **Penium minutum** (Ralfs) Cleve.

(Pl. X, figs. 1, 2.)

Docidium minutum Ralfs, Brit. Desm. 1848, p. 158, t. 26, f. 5; Reinsch, Algenfl. Franken, 1867, p. 183; Jacobs. Desm. Danem. 1875, p. 162, t. 7, f. 9; Wolle, Desm. U. S. 1884, p. 52, t. 10, f. 9; t. 50, f. 29–31; Cooke, Brit. Desm. 1886, p. 16, t. 8, f. 1; Roy & Biss. Scott. Desm. 1894, p. 49 (sep.).

Penium Ralfsii De Bary, Conj. 1858, p. 45, 73, t. 5, f. 8; Roy & Biss. Scott. Desm. 1894, p. 253.

Penium minutum (Ralfs) Cleve, Sverig. Desm. 1864, p. 493; Rabenh. Flor. Europ. Algar. III, 1868, p. 122; Lund. Desm. Suec. 1871, p. 87; Wolle, Desm. U. S. 1884, p. 35, t. 5, f. 19, 20; Wille, Sydamerik. Algfl. 1884, p. 22; Racib. Nonn. Desm. Polon. 1885, p. 60; West, Alg. W. Ireland, 1892, p. 129 (forma *genuina*); Lütkem. Desm. Attersees, 1893, p. 545; Nordst. Index Desm. 1896, p. 172; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 78; Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 48; Alg. N. Ireland, 1902, p. 22; Freshw. Alg. Ceylon, 1902, p. 136.

Pleurotænium minutum Delp. Desm. subalp. 1877, p. 131, t. 20, f. 17–21; De Toni, Syll. Alg. 1889, p. 904.

Calocylindrus minutus Kirchn. Alg. Schles. 1878, p. 142; Wolle, Desm. U. S. 1884, p. 54, t. 12, f. 12.

Dysphinctium minutum Hansg. in Oesterr. bot. Zeitschr. 1887, xxxvii, p. 99; Prodr. Algenfl. Böhm. 1888, p. 185.

Cells of medium size, elongate, 8–12 times longer than their diameter, almost cylindrical, with a distinct median constriction, very gradually attenuated towards the apices, which are truncate; cell-wall colourless, smooth or minutely punctate; chloroplasts variable, generally axile with a central row of about 6 pyrenoids and several irregular longitudinal ridges.

Zygospore unknown.

Length 97–168 μ; breadth 12·5–18 μ; breadth of apices 8·5–11 μ.

England.—Cumberland! Westmoreland! (*Bissett*). Lancashire! W., N., and E. Yorks! Sussex (*Ralfs*). Hants! Devon! Cornwall! (*Marquand*).

Wales.—General, but scarce!

Scotland.—General, but scarce! (*Roy & Bissett*). Common in the Outer Hebrides and west of Scotland!

Ireland.—Generally distributed in the west and south-west! Donegal! Londonderry! Down! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Italy. Poland. Russia. Norway. Sweden. Ceylon. West Africa. United States. British Guiana. Brazil.

This Desmid is by no means common, although it often occurs in abundance in the *Sphagnum*-bogs of the western parts of the British Isles. Its position in the genus *Penium* is questionable, but its position in any other genus would be still more so. It was originally placed by Ralfs in *Docidium*, from which genus, as now generally accepted, it must perforce be excluded.

Its true position is in the Tribe *Cosmarieæ*, but it cannot be regarded as an elongated *Cosmarium*, neither can it be reasonably placed in a distinct genus. Until more is known concerning its structure it is best left in the genus *Penium*, particularly as its zygospore is still unknown.

The chloroplasts are very variable, especially when the plant occurs in large quantity. The longitudinal ridges are most irregular, often being entirely absent, and the chloroplast of each semicell sometimes becomes quite parietal. We have observed a few specimens in which it was a parietal spirally-twisted band, similar to the chloroplast of certain species of *Spirotænia*.

There are numerous varieties of it, most of which are British.

Forma **major** Lund. (Pl. X, fig. 4.)

Penium minutum forma *major* Lund. Desm. Suec. 1871, p. 87; Racib. Nonn. Desm. Polon. 1885, p. 61; West, Alg. W. Ireland, 1892, p. 129.

Length 170–270 μ; breadth 12·5–18 μ.

SCOTLAND.—Harris, Outer Hebrides!

IRELAND.—Ballynahinch, Galway!

Geogr. Distribution.—Austria. Sweden.

Forma **minor** Racib. (Pl. X, fig. 3.)

Forma *minor* Racib. Nonn. Desm. Polon. 1885, p. 61; West, Alg. W. Ireland, 1892, p. 129.

Length 60–85 μ; breadth 5·5–11·5 μ; breadth of apex 4·5–9 μ.

SCOTLAND.—Sligachan in Skye, Inverness!

IRELAND.—Cromagloun, Kerry!

Geogr. Distribution.—Poland. West Africa.

Var. **gracile** Wille. (Pl. X, fig. 6.)

Var. *gracile* Wille, Norges Ferskv. Alg. 1880, p. 51, t. 2, f. 33; Racib. Nonn. Desm. Polon. 1885, p. 60; West, Alg. N. Wales, 1890, p. 284; Alg. W. Ireland, 1892, p. 129; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 78; Some N. Amer. Desm. 1896, p. 237; Freshw. Alg. Ceylon, 1902, p. 136.

Cells elongated, 14–20 times longer than their diameter.

Length 110–220 μ; breadth 7·5–12 μ.

WALES.—Capel Curig, Carnarvonshire!

IRELAND.—Near Oughterard and Ballynahinch, Galway! Cromagloun, Adrigole, and Upper Lake of Killarney, Kerry!

Geogr. Distribution.—Norway. Lapland. West Africa. United States. Cuba.

Some of the American specimens of this variety have reached a length of 268 μ, being 30 times longer than the diameter, thus merging into the next variety.

Var. **elongatum** West & G. S. West. (Pl. X, fig. 8.)

Var. *elongatum* West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 136.
Docidium elongatum West. Alg. N. Wales, 1890, p. 284, t. v, f. 17.

Cells very elongate, 30–40 times longer than their diameter.

Length 257–330 μ; breadth 8–9 μ.

WALES.—Capel Curig, Carnarvonshire!

Geogr. Distribution.—Ceylon.

Var. **tumidum** Wille. (Pl. X, fig. 5.)

Var. *tumidum* Wille, Norges Ferskv. Alg. 1880, p. 51. t. 2, f. 34; Racib. Nonn. Desm. Polon. 1885, p. 61; West, Alg. W. Ireland, 1892, p. 129.

Cells about 5 times longer than the diameter, semicells distinctly inflated.

Length 90–102 μ; greatest breadth 15–20 μ.

IRELAND.—Ballynahinch, Galway!

Geogr. Distribution.—Norway.

Var. **alpinum** Racib. (Pl. X, fig. 9.)

Var. *alpinum* Racib, Nonn. Desm. Polon. 1885, p. 61; West, Alg. W. Ireland, 1892, p. 130.

Semicells slightly more attenuated than in the typical form, with the apices truncately rounded; cells 8–12 times longer than their diameter.

Length 81–170 μ; breadth 9·5–15 μ.

WALES.—Moel Siabod, and bogs above the Capel Curig lakes, Carnarvonshire!

IRELAND.—Oorid Lough, Galway! Cromagloun, Kerry!

Geogr. Distribution.—Poland.

Var. **polonicum** (Racib) West. (Pl. X, fig. 10.)

Var. *polonicum* (Racib.) West, Alg. W. Ireland, 1892, p. 130; West & G. S. West, Alg. N. Ireland, 1902, p. 22.
Penium (*Docidium ?*) *polonicum* Racib. Nonn. Desm. Polon. 1885, p. 61, t. 5, f. 12; Nordst. Index Desm. 1896, p. 203.

Semicells gradually and strikingly attenuated towards the apices, which are rounded; cells 10–11 times longer than their diameter.

Length 104–165 μ; breadth 10·5–15 μ; breadth near the apex 3·5–6 μ.

SCOTLAND.—Rhiconich, Sutherland! N. Uist, Outer Hebrides!

IRELAND.—Cromagloun, Kerry! Glendoan, Donegal!

Geogr. Distribution.—Poland.

Var. **crassum** West. (Pl. X, figs. 11–13.)

Var. *crassum* West, Alg. W. Ireland, 1892, p. 130, t. 20, f. 1–3 (inclus. f. *punctata* and f. *inflata*); West & G. S. West. Welw. Afric. Freshw. Alg. 1897, p. 78; Some Desm. U. S. 1898, p. 282; Alg. N. Ireland, 1902, p. 22.

Cells stout, sometimes a little inflated, 4–4½ times longer than their diameter, apices very broad and truncate.

Length 46–98 μ; breadth 16–21 μ.

WALES.—Llyn-an-afon, Carnarvonshire!

SCOTLAND.—Rhiconich, Sutherland! Loch Luichart, Ross!

IRELAND.—Ballynahinch and Nacoogarrow Lough, Galway! Adrigole and Carrantuohill, Kerry! Near Gweedore, Donegal!

Geogr. Distribution.—Lapland. West Africa. Brazil.

Var. **undulatum** West. (Pl. X, fig. 7.)

Var. *undulatum* West, Alg. W. Ireland, 1892, p. 130, t. 20, f. 4.

Semicells regularly but very slightly 5-undulate.

Length 101 μ; breadth near base of semicells 12·5 μ, near apex 9 μ.

IRELAND.—Cromagloun, Kerry!

Tribe 4. CLOSTERIEÆ.

The cells are elongate, usually curved and commonly attenuated towards each extremity. There is no median constriction, and the plants are circular in cross-section. The place of division is regularly situated in the middle region of the cell, and the cell-wall generally possesses pores. They are symmetrical about *one* longitudinal plane.

Genus 8. **ROYA** West & G. S. West, 1896.

West & G. S. West, New and Int. Freshw. Alg. 1896, p. 152.
Nordst. Index Desm. 1896, p. 280.

Cells very slightly arcuate, almost exactly cylindrical, scarcely attenuated towards the extremities, apices subtruncate or obtusely rounded; cell-wall smooth and colourless; one chloroplast in each cell, generally with a small excavation in the middle of the concave side in which the nucleus is lodged; the extremities of the chloroplast are convex and extend almost to the extreme ends of the cell, there not being any apical vacuoles nor moving corpuscles; pyrenoids 4–14 in a single series.

The late Dr. J. Roy first pointed out the characters of this genus, remarking under "*Closterium Pseudoclosterium*" that "this curious little species forms one of a small group of which *Cl. obtusum* Bréb. may be taken as the type. They do not accord well with *Closterium*, and undoubtedly should be placed in a new genus." As we had been fully convinced for some time that these plants could not remain in the genus *Closterium*, we described the genus *Roya* in 1896.

Roya is a well-marked genus which can be readily distinguished from either *Penium* or *Closterium;* in fact the differences between *Roya* and those genera are far more striking than the differences between those genera themselves. We think the genus sufficiently distinct from *Closterium* by reason of the unbroken chloroplast which extends to the extremities of the cells, leaving no room for apical vacuoles. Specimens of certain species of *Closterium* are occasionally without apical vacuoles containing moving corpuscles, but they have always sufficient space for the lodgment of a vacuole within each apex, the extremity of the chloroplast falling short of the apex and being almost invariably *hollowed* for this purpose. We are inclined to believe that the absence of the moving gypsum-corpuscles in the apical vacuoles of a *Closterium* is a very abnormal feature, and one which has been produced by pathological conditions. There is not the slightest trace of apical vacuoles in the genus *Roya*, and the extremities of the chloroplasts are *convex* in order to fit as closely into the rounded ends of the cell as possible. Other differences from the vast majority of *Closteria* are in the lateral position of the nucleus, which is lodged in a special excavation of the chloroplast, and in the almost entire absence of attenuation of the cells.

There are only three described species, all of which are rare British Desmids.

1. **Roya obtusa** (Bréb.) West & G. S. West.

(Pl. X, fig. 27.)

Closterium obtusum Bréb. Liste Desm. 1856, p. 154, t. 2, f. 46; Arch. in Pritch. Infus. 1861, p. 746; Rabenh. Flor. Europ. Algar. III, 1868, p. 103; Kirchn. Beitr. Algenfl. Würtemb. 1880, p. 173; Wolle, Desm. U. S. 1884, p. 38, t. 6, f. 1; Cooke, Brit. Desm. 1886, p. 19, t. 10, f. 4; West, Alg. N. Wales, 1890, p. 284; Alg. W. Ireland, 1892, p. 121; Nordst. Index Desm. 1896, p. 186.

Closterium obtusum a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 8, t. 1, f. 2 *a* et *b*.

Closterium obtusum b. *major* Racib. Nonn. Desm. Polon. 1885, p. 63.

Arthrodia obtusa Kuntze Revis. Gen. Plant, 1891, p. 883.

Roya obtusa (Bréb.) West & G. S. West, New and Int. Freshw. Alg. 1896, p. 152; Some Desm. U. S. 1898, p. 282; Alga-fl. Yorks. 1900, p. 48.

Cells small, cylindrical, 4–10 times longer than their diameter, very slightly curved, apices obtusely rounded; with 4–8 pyrenoids in the chloroplast.

Zygospore globose and smooth (according to Kirchner).

Length 75–148 μ; breadth 9–15 μ.

England.—Greetland and Cullingworth, W. Yorks! Strensall, E. Yorks! Epping Forest, Essex! Esher West-end Common, Surrey! Enbridge Lake, Hants (*Roy*).

Wales.—Capel Curig, Carnarvonshire!

Scotland.—Ross, Aberdeen, Inverness, Kincardine, Perth, Argyll (*Roy* & *Bissett*).

IRELAND.—Kylemore, Galway! Carrantuohill, Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Poland. Italy. Norway. Sweden. Java. United States. Brazil.

Var. **montana** West & G. S. West. (Pl. X, figs. 28, 29.)

? *Closterium obtusum* Lund. Desm. Suec. 1871, p. 77; Wille, Norges Ferskv. Alg. 1880, p. 58; Heimerl, Desm. alp. 1891, p. 592.
? *Closterium obtusum a. minor* Racib. Nonn. Desm. Polon. 1885, p. 62.
Closterium obtusum forma *apicibus subtruncatis* West, Alg. Eng. Lake Distr. 1892, p. 719, t. 9, f. 13.
Roya obtusa var. *montana* West & G. S. West, New and Int. Freshw. Alg. 1896, p. 152, t. 3, f. 23, 24; Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 48.

A smaller variety with the apices distinctly subtruncate.

Length 48–81 μ; breadth 5–6 μ.

ENGLAND.—Helvellyn, Westmoreland! Cocket Moss, Baildon Moor, and Cam Fell, W. Yorks!

WALES.—Llyn Pencraig, near Bettws-y-coed, Carnarvonshire!

Geogr. Distribution.—Austria.

The var. *montana* is more frequently met with in abundance than the typical form, generally occurring amongst other algæ or amongst mosses on wet rocks.

2. **Roya cambrica** West & G. S. West.
(Pl. X, fig. 31.)

Roya cambrica West & G. S. West, Notes Alg. III, p. 9 (sep.), t. 446, p. 11.

Cells of medium size, cylindrical, 25–26 times longer than their diameter, slightly curved, apices subtruncate and scarcely narrowed; chloroplast with 12–14 pyrenoids.

Zygospore unknown.

Length 173–177 μ; breadth 6·2–6·7 μ; breadth of apices 4·6–4·8 μ.

WALES.—Llyn Ogwen and Llyn Cwlyd, Carnarvonshire!

3. **Roya Pseudoclosterium** (Roy) West & G. S. West. (Pl. X, fig. 30.)

Closterium Pseudoclosterium Roy in Roy & Biss. Scott. Desm. 1894, p. 247; Nordst. Index Desm. 1896, p. 208.
Roya Pseudoclosterium West & G. S. West, New and Int. Freshw. Alg. 1896, p. 153; Alga-fl. Yorks. 1900, p. 48; Alg. N. Ireland, 1902, p. 22.

Cells very slender, elongate, cylindrical, 40–60 times longer than their diameter, almost straight, apices truncately rounded; chloroplast with 4–6 pyrenoids.

Zygospore unknown.

Length 96–192 μ; breadth 2·6–3·5 μ.

ENGLAND.—Pilmoor, N. Yorks!

WALES.—"North Wales" (*Roy*).

SCOTLAND.—Slewdrum and Upper Powlair, Aberdeen; Cammie, Kerloch, Muiryhaugh, and Dalbrake, Kincardine (*Roy* & *Bissett*). Rhiconich, Sutherland!

IRELAND.—Near Glenties and Lough Anna, Donegal!

Genus 9. **CLOSTERIUM** Nitzsch, 1817.

Nitzsch, Beitr. zur Infusor. oder Naturbeschr. der Zerkarien und Bazillarien, 1817, pp. 60 and 67.
Corda, in Alman. de Carlsbad, 1835, p. 193.
Menegh. Synops. Desm. 1840, p. 229.
Ralfs, Brit. Desm. 1848, p. 159.
Kütz. Spec. Alg. 1849, p. 163.
Arch. in Pritch. Infus. 1861, pp. 720 and 746.
Rabenh. Flor. Europ. Algar. III, 1868, p. 123.
Kirchn. Alg. Schles, 1878, p. 137.
Gay, Monogr. loc. Conj. 1884, p. 39.
Wolle, Desm. U.S. 1884, p. 37.
Cooke, Brit. Desm. 1886, p. 17.
De Toni, Syll. Alg. 1889, p. 817.

Cells elongated, always more or less attenuated, generally curved and often strongly arcuate or lunate, unconstricted; poles obtuse, truncate, rostrate or attenuated to fine needle-like points; cell-wall smooth or striated, often brown or yellow-brown in colour; one chloroplast in each semicell, with a variable number of longitudinal ridges; pyrenoids few or many, in a single axile series or scattered irregularly through the chloroplast; with a terminal vacuole between the end of the chloroplast and the extremity of the cell, containing one or many crystals of gypsum which exhibit a constant motion. Cells in cross-section circular.

One of the principal features of the plants of this genus is the curvature of the cells. This curvature is very constant for any one species and can be used as a specific character, the amount of curvature of the outer margin being expressed in degrees of arc. The measurement of length in this genus is the straight line between the apices, and the breadth is the diameter across the middle of the cell.

Kuntze in his 'Revis. gen. plant.' substituted "*Arthrodia*" for *Closterium*. This name was given by Rafinesque (in Desv. Journ. 1813, i, p. 235) to some Alga which, from his diagnosis, might have been a *Closterium*, *Penium*, *Docidium*, *Pleurotænium*, *Cylindrocystis*, *Tetmemorus*, or even an *Ankistrodesmus*. Nordstedt (in Hedwigia, 1893, Heft 3, p. 148) has pointed out that "*Arthrodia*" must always remain a "genus ignotum et nomen delendum."

In *Cl. acutum* and a few others the chloroplasts are devoid of longitudinal ridges.

There is very little difference between *Closterium* and certain species of *Penium*, and it is doubtful whether *Penium Libellula* and *P. navicula* should not be considered as straight species of *Closterium*.

At the points of division transverse lines (commonly termed "sutures") are often seen, and their number denotes the number of cell-divisions. In some species, in which growth takes place after cell-division, these transverse sutures occur at different parts of the cell. They are useless as specific characters, but the growth subsequent to division has been utilized by Lütkemüller as a means of subdividing the genus.

SECTION A. Cells with a median girdle ("Gürtelband") or cylindrical piece of cell-wall which arises subsequent to cell-division and is interpolated between the new and old semicells.

* Cells strongly curved, lunate; cell-wall striated.

1. *Cl. Cynthia.*
2. *Cl. Lagoense.*
3. *Cl. Archerianum.*
4. *Cl. porrectum.*

** Cells slightly curved, ventral margin sometimes almost straight.

† Cell-wall smooth.

5. *Cl. didymotocum.*
6. *Cl. macilentum.*

†† Cell-wall striated.

7. *Cl. angustatum.*
8. *Cl. costatum.*
9. *Cl. regulare.*
10. *Cl. striolatum.*
11. *Cl. intermedium.*
12. *Cl. Ulna.*
13. *Cl. juncidum.*

Section B. Cells without a median girdle, the adult condition being attained on the growth to maturity of the younger semicells.

* Cells strongly curved, lunate.

† Cell-wall smooth.

α. Ventral margin not distinctly tumid.

14. *Cl. Dianæ.*
15. *Cl. Pseudodianæ.*
16. *Cl. parvulum.*
17. *Cl. Jenneri.*
18. *Cl. incurvum.*
19. *Cl. Venus.*
20. *Cl. calosporum.*
21. *Cl. eboracense.*

β. Ventral margin distinctly tumid.

22. *Cl. Leibleinii.*
23. *Cl. moniliferum.*
24. *Cl. Ehrenbergii.*

†† Cell-wall striated. Ventral margin distinctly tumid.

25. *Cl. Malinvernianum.*

** Cells slightly curved, ventral margin almost straight or slightly concave.

† Cell-wall smooth.

α. Cells lanceolate, gradually attenuated to the poles, which are usually subacute.

26. *Cl. acerosum.*
27. *Cl. lanceolatum.*
28. *Cl. Lunula.*
29. *Cl. sigmoideum.*
30. *Cl. Siliqua.*
31. *Cl. peracerosum.*
32. *Cl. littorale.*
33. *Cl. tumidum.*
34. *Cl. Cornu.*

β. Cells lanceolate, slightly attenuated to the poles, which are obtuse or truncate.

‡ Poles truncate.

35. *Cl. abruptum.*
36. *Cl. toxon.*

‡‡ Poles rounded and inflated.

37. *Cl. Balmacarense.*

38. *Cl. Scoticum.*

‡‡‡ Poles obtusely rounded.

39. *Cl. pusillum.*

40. *Cl. monotænium.*

γ. Cells narrow and elongate; apices attenuate, acute and generally incurved.

‡ Poles slightly recurved.

41. *Cl. prælongum.*

‡‡ Poles incurved.

42. *Cl. strigosum.*

43. *Cl. gracile.*

44. *Cl. Lundellii.*

†† Cell-wall striated.

α. Curvature regular; poles suddenly attenuated.

45. *Cl. attenuatum.*

β. Poles slightly recurved.

46. *Cl. turgidum.*

47. *Cl. Pritchardianum.*

*** Cells slightly curved; poles very much attenuated, acute, subacute, or rounded.

† Cell-wall smooth.

α. Cells almost straight, much elongated.

48. *Cl. pronum.*

49. *Cl. aciculare.*

β. Cells more or less distinctly curved (rarely straight), relatively shorter.

50. *Cl. ceratium.*

51. *Cl. acutum.*

52. *Cl. subulatum.*

53. *Cl. idiosporum.*

†† Cell-wall striated.

α. Median portion of cells not (or rarely) ventricose; poles incurved.

54. *Cl. lineatum.*

β. Median portion of cells ventricose; gradually attenuated to the poles.

55. *Cl. Ralfsii.*

56. *Cl. decorum.*

57. *Cl. laterale.*

γ. Median portion of cells ventricose; suddenly attenuated into elongate poles.

58. *Cl. Kützingii.*

59. *Cl. rostratum.*

60. *Cl. setaceum.*

Section A.

1. **Closterium Cynthia** De Not.

(Pl. XI, figs. 1–3.)

Closterium Cynthia De Not. Desm. Ital. 1867, p. 65, t. 7, f. 71; Lund. Desm. Suec. 1871, p. 78; Cooke, Brit. Desm. 1886, p. 26, t. 13, f. 2; West, Alg. N. Wales, 1890, p. 285; Alg. W. Ireland, 1892, p. 123; Roy & Biss. Scott. Desm. 1894, p. 244; West & G. S. West, Some N. Amer. Desm. 1896, p. 237; Nordst. Index Desm. 1896, p. 96; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 51; Alg. N. Ireland, 1902, p. 24; Freshw. Alg. Ceylon, 1902, p. 140.

Closterium Archerianum c. *Cynthia* Klebs, Desm. Ostpreuss. 1879, p. 13, t. 1, f. 12, *a* et *c*.

Arthrodia Cynthia Kuntze, Revis. gen. plant. 1891, p. 883.

Cells small, about 6–10 times longer than their diameter, strongly curved, outer margin 120°–140° (rarely 170°) of arc, inner margin not tumid, gradually narrowed to the apices, which are obtusely rounded; pyrenoids 3–6 in each chloroplast; terminal vacuoles generally with one moving granule; cell-wall finely striate, about 14 striæ visible across the cell, pale yellow or yellow-brown in colour.

Zygospore globose and smooth.

Distance between apices 73–160 μ; breadth 11–18 μ; diam. of zygosp. 28–31 μ.

England.—Westmoreland! (*Bissett*). N. Yorks! Lancashire! Surrey! Hants! Cornwall! (*Marquand*).

Wales.—Capel Curig! (*Cooke & Wills*), Pen-y-gwryd (*Roy*), Llyn Padarn!, Llyn Idwal!, and near Conway, Carnarvonshire!

Scotland.—Sutherland!, Ross, Inverness!, Nairn, Aberdeen!, Kincardine, Forfar!, Perth!, Dumbarton (*Roy & Bissett*). Orkneys (*Roy & Bissett*).

Ireland.—Galway! Mayo! Kerry! Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Austria. Hungary. Italy. Norway. Sweden. Denmark. India. Ceylon. Sumatra. New Zealand. Australia. East Africa. United States. Brazil.

This is a very well-marked species which could only be confused with *Cl. Jenneri*, *Cl. parvulum*, or *Cl. Venus*. From all these species it differs in the single corpuscle present in the terminal vacuoles and in the striated cell-wall. It also differs in its curvature from *Cl. Jenneri* and *Cl. Venus*, and it is relatively broader than *Cl. parvulum*.

Var. **curvatissimum** West & G. S. West. (Pl. XI, fig. 4.)

Cl. Cynthia var. *curvatissimum* West & G. S. West, Scott. Freshw. Plankton, I, 1903, p. 537, t. 14, f. 3.

A variety with the cells much elongated and the apices correspondingly incurved; each chloroplast with 6 pyrenoids; curvature 210° of arc.

Distance between apices 88 μ; breadth 12·5 μ.

SCOTLAND.—Plankton of Loch a Bhursta, Benbecula, Outer Hebrides!

The curvature of this plant, which occupies 210° of arc, is the greatest curvature known to exist in the genus. A distance of 102 μ can be measured along the curvature, although the apices are only 88 μ apart.

2. Closterium Lagoense Nordst.

(Pl. XI, figs. 5–7.)

Closterium Lagoense Nordst. Desm. Brasil. 1870, p. 203, t. 2, f. 2; Arch. in Quart. Journ. Micr. Sci. 1873, p. 213; Cooke, Brit. Desm. 1886, p. 28, t. 12, f. 5; West & G. S. West, Desm. Singapore, 1897, p. 159; Nordst. Index Desm. 1896, p. 154.

Arthrodia Lagoense Kuntze, Rev. gen. plant. 1891, p. 883.

Cells small, 6–7½ times longer than their diameter, strongly curved, outer margin 120°–150° of arc, inner margin not tumid but sometimes straight in its median portion, gradually narrowed to the apices, which are slightly dilated, obtuse, and suddenly attenuated; cell-wall finely striate, about 16 striæ visible across the cell, pale yellow or becoming brown in colour; each chloroplast with about 5 pyrenoids in an axile series.

Zygospore unknown.

Distance between apices 138–194 μ; breadth, 25–28 μ.

ENGLAND.—Enbridge Lake, Hants (*Roy*).

IRELAND.—Galway (*Archer*).

Geogr. Distribution.—Singapore. Java (var.). Madagascar (var.). Brazil.

3. **Closterium Archerianum** Cleve.

(Pl. XI, figs. 8–10.)

Closterium Archerianum Cleve, in Lund. Desm. Suec. 1871, p. 77, t. 5, f. 13; Jacobs. Desm. Danem, 1875, p. 175, t. 7, f. 4; Cooke, Brit. Desm. 1886, p. 27, t. 13, f. 5; West, Alg. N. Wales, 1890, p. 285; Alg. W. Ireland, 1892, p. 123; Roy & Biss. Scott. Desm. 1894, p. 243; Nordst. Index Desm. 1896, p. 50; West & G. S. West, Alg. S. England, 1897, p. 481; Lütkem. Desm. Millstättersees, 1900, p. 3 (sep.); West & G. S. West, Alg. N. Ireland, 1902, p. 24.

Closterium Archerianum a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 13, t. 1, f. 13 *h*, t. 2, f. 1.

Arthrodia Archeriana Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, about 11 times longer than the diameter, strongly curved, outer margin about 123°–145° of arc, inner margin not tumid, gradually and regularly attenuated to the apices, which are narrow and obtusely rounded; cell-wall pale yellow or brown in colour, striate, striæ rather variable, from 8 to 11 visible across the cell; each chloroplast with 5 or 6 pyrenoids; terminal vacuoles indistinct, with one moving granule.

Zygospore subglobose and smooth.

Distance between apices 196–230 μ; breadth 18·5–30 μ; diam. zygosp. 36–46 μ.

ENGLAND.—Loughrigg and Bowness, Westmoreland! Delamere, Cheshire (*Roy*). New Forest, Hants! Gunwen Moor, Cornwall!

WALES.—Capel Curig and Llyn Padarn, Carnarvonshire!

SCOTLAND.—Ross, Aberdeen, Kincardine, Forfar, Perth, Stirling, Argyll (*Roy & Bissett*). Rhiconich and Loch Inver, Sutherland!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Antrim! Armagh!

Geogr. Distribution.—France. Germany. Austria. Norway. Sweden. Denmark. Lapland. Russia. India. Java. Azores.

We give a figure (Pl. XI, fig. 11) of a coarsely striated form of this species which somewhat approaches *Cl. porrectum* var. *angustatum*.

4. **Closterium porrectum** Nordst.

(Pl. XI, fig. 12.)

Closterium porrectum Nordst. Desm. Brasil. 1870, p. 203, t. 2, f. 1; Alg. Brasil. 1877, p. 16; Boergesen, Desm. Brasil. 1890, p. 933. *Arthrodia porrecta* Kuntze, Revis. gen. plant. 1891, p. 884.

Cells of medium size, about 12 times longer than their diameter, very strongly arcuate, outer margin about 160° of arc, inner margin not tumid, gradually and uniformly attenuated to the apices, which are narrow and obtusely rounded; cell-wall pale yellow-brown, strongly striate, about 6 striæ visible across the cell.

Zygospore unknown.

Distance between the apices 225–270 μ; breadth 24–30 μ.

Unknown from the British Islands.

Geogr. Distribution.—Brazil.

Var. **angustatum** *var. nov.* (Pl. XI, fig. 13.)

Cells narrower than in the typical form and slightly less curved, about 14 or 15 times longer than their diameter, outer margin about 140–145° of arc; cell-wall brown in colour, 7 strong striæ visible across the cell.

Distance between apices 195 μ; breadth 15·5 μ.

SCOTLAND.—Near Balallan, Lewis, Outer Hebrides!

This variety stands intermediate between *Cl. Archerianum Cl. porrectum,* and it bears a great resemblance to some of the more sparsely striated forms of the former species.

5. **Closterium didymotocum** Corda.

(Pl. XII, figs. 1–5.)

Closterium didymotocum Corda, in Alm. de Carlsbad. 1835, pp. 185, 190, 192, 209, t. 5, f. 64, 65; Ralfs, Brit. Desm. 1848, pp. 168–169, t. 28, f. 7 *a* and *b*; Arch. in Pritch. Infus. 1861, p. 746, t. 3, f. 39; Rabenh. Flor. Europ. Algar. III, 1868, p. 125; Jacobs. Desm. Danem. 1875, p. 175, t. 7, f. 6; Delp. Desm. subalp. 1877, p. 103, t. 17, f. 31–37; Kirchn. Alg. Schles. 1878, p. 138; Wolle, Desm. U.S. 1884, p. 39, t. 8, f. 12, 13;

Cooke, Brit. Desm. 1886, p. 17, t. 8, f. 2 *b* and *d*; Hansg. Prodr. Algenfl. Böhm. 1888, p. 179; Hauptfl. Zellm. u. Hüllgallerte Desm. 1888, p. 99, t. 3, f. 29 and 37; West, Alg. N. Wales, 1890, p. 284; Heimerl, Desm. Alp. 1891, p. 592; West, Alg. W. Ireland, 1892, p. 120; Johnson, Rare Desm. U.S. I, 1894, p. 286; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 107; West & G. S. West, Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 53; Alg. N. Ireland, 1902, p. 22.

Cl. subrectum Bréb. Alg. Falaise, 1835, p. 59, t. 8.

Cl. Baillyanum Bréb. in Jenner's Flor. Tunbridge Wells, 1845, p. xix.

Cl. Ensis Focke, Phys. Stud. I, 1847, p. 59, t. 3, f. 31.

Cl. didymotocum var. *Baillyanum* Bréb. in Ralfs' Brit. Desm. 1848, p. 169, t. 28, f. 7 *c* and *d*; Rabenh. Flor. Europ. Algar. III, 1868, p. 125; Cooke, Brit. Desm. 1886, t. 8, f. 2 *a*, *c*, *e*; Hansg. Prodr. Algenfl. Böhm. 1888, p. 179.

Cl. antiacerosum De Not. Desm. Ital. 1867, p. 61, t. 6, f. 63; Nordst. Norges Desm. 1873, p. 41; Roy & Biss. Scott. Desm. 1894, p. 243.

Arthrodia didymotoca Kuntze Revis. gen. plant. 1891, p. 883.

Closterium fractum Turn. Freshw. Alg. E. India, 1893, p. 20.

Cells large, 9–12 times longer than their diameter, slightly curved, outer margin from 27° to 32° of arc, inner margin very slightly concave or almost straight, median portion of cell with subparallel sides, gradually and slightly attenuated towards the apices, which are broad and truncate with rounded angles (and sometimes very slightly recurved); cell-wall reddish-brown or yellow-brown in colour, smooth or very rarely with traces of a fine striation, with an annular thickening of a dark brown colour at each apex; each chloroplast with 5–7 large pyrenoids; terminal vacuoles with many moving granules.

Zygospore unknown.

Distance between apices (= length) 295–672 μ; breadth 24–48 μ; breadth of apices 13–20 μ.

ENGLAND.—Westmoreland! (*Ralfs*; *Bissett*). W. Yorks! Lancashire! Cumberland! Warwick (*Wills*). Sussex (*Ralfs*). Surrey! (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*).

WALES.—General in Carnarvonshire (at 2,200 ft. on Glyder Fach)! Dolgelly, Merioneth!

SCOTLAND.—General! (*Roy & Bissett*). General in the Outer Hebrides!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria.

Hungary. Italy. Norway. Sweden. Denmark. Lapland in Russia. Faeroes. India. Singapore (var.). East Africa. United States.

This is one of the most striking species of the genus, and is generally distributed over the boggy districts of the British Islands. It has in the past received a number of different names, largely owing to its variability and to its periodical increase in size after division. The forms which have been named "var. *Baillyanum*" are only young individuals before the development of the median girdle, which is a cylindrical piece of cell-wall interpolated between the two semicells. This growth subsequent to cell-division has given rise to many misconceptions with regard to this species.

The apices are usually thickened and of a darker brown than the rest of the cell-wall. Some observers have remarked the presence of fine striolations, but they must be of very rare occurrence. We have examined thousands of specimens of this species from all over the world and have never yet detected them.

Var. **asperulatum** *var. nov.* (Pl. XII, figs. 6, 7.)

More slender than the typical form, being 12–14 times longer than the diameter, rather more attenuate, apices slightly recurved and not thickened; cell-wall colourless, minutely asperulate, being covered with somewhat irregular and depressed granules.

Length 405–418 μ; breadth 28–34 μ.

ENGLAND.—New Forest, Hants!

6. **Closterium macilentum** Bréb.

(Pl. XII, figs. 8–10.)

Closterium macilentum Bréb. Liste Desm. 1856, p. 153, t. 2, f. 36; Arch. in Pritch. Infus. 1861, p. 747; Rabenh. Flor. Europ. Algar. III, 1868, p. 131; Delp. Desm. subalp. 1877, p. 107, t. 17, f. 60–62; Kirchn. Alg. Schles. 1878, p. 137; Wolle, Desm. U.S. 1884, p. 38, t. 6, f. 6; Hansg. Prodr. Algenfl. Böhm. 1888, p. 178; West, Alg. N. Wales, 1890, p. 284; Gutw. Flor. glonów Galic. 1892, p. 120; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 162; West & G. S. West, Some Desm. U.S. 1898, p. 283; Notes Alg. III, 1903, p. 9 (sep.).
Arthrodia macilenta Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, very elongate and narrow, 24–40 times longer than their diameter, slightly curved towards the extremities, median portion straight with parallel sides, inner margin not tumid, gradually attenuated towards the apices, which are obtusely rounded; cell-wall smooth and colourless; each chloroplast with 8 or 9 pyrenoids; terminal vacuoles with several moving granules.

Zygospore subglobose and smooth.

Length 264–722 μ; breadth 11–20 μ; diam. of zygosp. 32 μ.

ENGLAND.—Enbridge Lake, Hants (*Roy*). Near Mullion, Cornwall!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Ross, Inverness, Aberdeen, Forfar, Perth (*Roy & Bissett*).

IRELAND.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Norway. Faeroes. India. Japan. United States. Brazil.

7. **Closterium angustatum** Kütz.

(Pl. XII, figs. 11–13.)

Closterium angustatum Kütz, Phyc. germ. 1845, p. 132; Ralfs. Brit. Desm. 1848, p. 172, t. 29, f. 4; Kütz. Spec. Algar. 1849, p. 166; Arch. in Pritch. Infus. 1861, p. 749; Rabenh. Flor. Europ. Algar. III, 1868, p. 126; Wolle, Desm. U.S. 1884, p. 40, t. 6, f. 21; Cooke, Brit. Desm. 1886, p. 30, t. 11, f. 3; Börg. Bornholm. Desm.-fl. 1889, p. 142, t. 6, f. 1; West, Alg. W. Ireland, 1892, p. 124; Schmidle, Beitr. Alg. Schwarzwald. 1893, p. 89, t. 3, f. 12; Roy & Biss. Scott. Desm. 1894, p. 243; Nordst. Index Desm. 1896, p. 45; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 54; Alg. N. Ireland, 1902, p. 24.

Closterium speciosum Turn. in Trans. Leeds Nat. Club, 1886, p. 10, t. 1, f. 17.

Arthrodia angustata Kuntze, Revis. gen. plant. 1891, p. 883.

Closterium angustatum var. *subrecta* Schmide, Beitr. Alg. Schwarzwald. 1893, p. 89, t. 3, f. 12.

Closterium angustatum forma *Eichleri* Gutw. Wykaz Glonów Wadow.-Makow. 1897, p. 124.

Closterium angustatum var. *speciosum* Schmidle, Lappmark Süsswasser-algen, 1898, p. 13, t. 1, f. 10.

Cells of medium size, 14–18 (sometimes only about 10) times longer than their diameter, moderately curved, outer margin from 45° to 51° of arc, inner margin not tumid, gradually but slightly attenuated from the middle to each extremity; apices truncately rounded or sometimes rounded, often slightly swollen and subcapitate; cell-wall reddish-brown in colour, generally darker at the apices, costate, with 4 costæ visible across the cell, costæ frequently subspirally disposed; each chloroplast with 4–7 pyrenoids in one axile series; terminal vacuoles with a number (12–20) of moving granules.

Zygospore unknown.

Distance between apices (= length) 290–403 μ; breadth 16–28 μ; breadth of apices 12–15 μ.

ENGLAND.—Westmoreland! (*Ralfs*). W. and N. Yorks (very scarce)! Lancashire! Sussex (*Ralfs*). Surrey! (*Ralfs*). Hants! (*Bennett*). Devon! (*Bennett*). Cornwall! (*Marquand*).

WALES.—Capel Curig! (*Cooke & Wills*), Pen-y-gwryd (*Roy*), Glyder Fach (at 2,200 ft.), Carnarvonshire! Ffestiniog and Dolgelly, Merioneth!

SCOTLAND.—Sutherland!, Ross!, Inverness!, Aberdeen!, Kincardine, Forfar, Perth!, Stirling, Argyll, Renfrew (*Roy & Bissett*). Kirkcudbright! Lewis and Harris, Outer Hebrides!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Italy. Norway. Sweden. Denmark. Lapland in Russia. India. Java. United States.

This is a most characteristic species by reason of the few strong costæ on the cell-wall. It exhibits much variation with regard to its extremities, the poles being truncate, rounded, or even subcapitate, and the costæ are frequently disposed in a subspiral manner. The forms most frequently met with in the British Islands possess slightly swollen extremities.

8. **Closterium costatum** Corda.

(Pl. XIII, figs. 1–3.)

Closterium costatum Corda, in Alm. de Carlsbad, 1834, p. 185, etc., t. 5 f. 61–63; Ralfs, Brit. Desm. 1848, p. 170, t. 21, f. 1; Arch. in Pritch.

Infus. 1861, p. 748; Rabenh. Flor. Europ. Algar. III, 1868, p. 126; Wolle, Desm. U.S. 1884, p. 42, t. 6, f. 19; Cooke, Brit. Desm. 1886, p. 28, t. 10, f. 3; West, Alg. W. Ireland, 1892, p. 123; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 85; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 54; Alg. N. Ireland, 1902, p. 24.

Cl. doliolatum Bréb. in Cheval. microscop. et usage, Paris, 1839, p. 272.

Cl. turgidulum Kütz. Phycol. germ. 1845, p. 132.

Cl. dilatatum Kütz. Phycol. germ. 1845, p. 132.

Cl. striolatum b. *costatum* Klebs, Desm. Ostpreuss. 1879, p. 14.

Arthrodia costata Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, 6–10 (commonly 7 or 8) times longer than their diameter, moderately curved, outer margin from 90° to 98° of arc, gradually attenuated towards the apices, which are rounded, truncately rounded, or rounded-conical; cell-wall reddish-brown, costate, with 6–8 costæ visible across the cell; each chloroplast with 6–7 pyrenoids in one axile series; terminal vacuoles with numerous moving granules.

Zygospore globose or ovoid-globose, smooth.

Distance between apices 340–405 μ; breadth 48–66 μ; diam. of zygosp. 100–120 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W. and N. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Warwick (*Wills*). Oxford! Gloucester (*Ralfs*). Essex! Middlesex! Sussex (*Ralfs*). Surrey! (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*).

WALES.—Fairly general!

SCOTLAND.—General! (*Roy & Bissett*). Outer Hebrides! Shetlands!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Antrim!

Geogr. Distribution.—France. Germany. Austria. Hungary. Italy. Norway. Sweden. Denmark. N. and S. Russia. Faeroes. Greenland. United States.

This is a characteristic species which exhibits a certain amount of variation. The number of costæ visible across the cell is usually six, but there may be as few as five or as many as eight, and occasionally the cell-wall is punctate between the costæ. The apices of the cells are generally angularly rounded and are often of a deeper colour than the rest of the cell-wall.

9. **Closterium regulare** Bréb.

(Pl. XIII, figs. 4–6.)

Closterium regulare Bréb. Liste Desm. 1856, p. 148, t. 2, f. 35; Rabenh. Flor. Europ. Algar. III, 1868, p. 126; Nordst. Freshw. Alg. N. Zeal. 1888, p. 78; Roy & Biss. Scott. Desm. 1894, p. 248; Nordst. Index Desm. 1896, p. 223; West & G. S. West, Alg. S. England, 1897, p. 481; Freshw. Chlorophy. Koh Chang, 1901, p. 82.
Closterium striolatum a Klebs, Desm. Ostpreuss. 1879, p. 14, t. 2, f. 2.
Arthrodia regularis Kuntze, Revis. gen. plant. 1891, p. 884.

Cells of medium size, about 9 times longer than the diameter, moderately curved, outer margin from 66° to 86° of arc, inner margin not tumid, gradually attenuated towards the apices, which are somewhat elongated and truncately or angularly rounded; cell-wall pale yellow-brown in colour and costate, with 11–12 costæ visible across the cell; each chloroplast with about 5 pyrenoids; terminal vacuoles with a number of moving granules.

Zygospore unknown.

Distance between apices 226–280 μ; breadth 24–33 μ; breadth of apices 6–9 μ.

ENGLAND.—Puttenham Common, Surrey (small forms)!

SCOTLAND.—Near Kingshouse, Argyll (*Roy & Bissett*).

Geogr. Distribution.—France. Norway. Lapland in Russia. India. Siam. Australia. West Africa.

This rare species occupies a position intermediate between *Cl. costatum* and *Cl. striolatum*. It is distinguished from the former by its somewhat smaller size, more attenuated apices, and by the greater number of costæ; from the latter it differs in its more attenuated and relatively narrower apices, and by the presence of 11 or 12 visible costæ instead of 14 or more striolations. The costæ of *Cl. regulare* are of about the same strength as those of *Cl. costatum*, but are much closer together; they are much stronger than the striæ of *Cl. striolatum*.

10. **Closterium striolatum** Ehrenb.

(Pl. XIII, figs. 7–16.)

Closterium striolatum Ehrenb. Entwick. Lebends. d. Infus. 1832, p. 68; Infus. 1838, p. 96, t. 6, f. xii; Menegh. Synops. Desm. 1840, p. 234; Hass. Brit. Freshw. Alg. 1845, p. 371, t. 87, f. 4; Ralfs, Brit. Desm.

1848, p. 170, t. 29, f. 2 *a–g*; Arch. in Pritch. Infus. 1861, p. 749, t. 2, f. 2 and 6; Rabenh. Flor. Europ. Algar. III, 1868, p. 242; Kirchn. Alg. Schles. 1878, p. 139 (a. *genuinum*); Gay, Mon. loc. Conj. 1884, p. 76; Wolle, Freshw. Alg. U.S. 1887, p. 24, t. 55, f. 5–8; Cooke, Brit. Desm. 1886, p. 29, t. 11, f. 1; Hansg. Prodr. Algenfl. Böhm. 1888, pp. 180 and 242; Hauptfl. Zellm. u. Hüllgallerte Desm. 1888, p. 99, t. 3, f. 28; West, Alg. W. Ireland, 1892, p. 124; Roy & Biss. Scott. Desm. 1894, p. 249; Nordst. Index Desm. 1896, p. 242; West & G. S. West, Desm. Singapore, 1897, p. 159; Alg. S. England, 1897, p. 481; Some Desm. U.S. 1898, p. 284; G. S. West, Variation Desm. 1899, p. 380; West & G. S. West, Alga-fl. Yorks. 1900, p. 55; Alg. N. Ireland, 1902, p. 24; Freshw. Alg. Ceylon, 1902, p. 137.

Cl. striolatum var. *tumidum* Rabenh. Flor. Europ. Algar. III, 1868, p. 126; De Toni, Syll. Algar. 1889, p. 826.

Cl. striolatum a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 14, t. 2, f. 4 *a*.

Cl. striolatum var. *orthonotum* Roy, Freshw. Alg. Enbridge Lake and Vicin. 1890, p. 336; West, Alg. W. Ireland, 1892, p. 124; Roy & Biss. Scott. Desm. 1894, p. 249; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 55.

Arthrodia striolata Kuntze, Revis. gen. plant. 1891, p. 884.

Cells of medium size, 8–12 times longer than their diameter, moderately curved, outer margin from 39° to 69° of arc, inner margin concave, never tumid, but sometimes straight in the middle, gradually attenuated to the apices, which are broad and truncate with rounded angles; cell-wall yellowish or yellowish-brown in colour, striated, with 14–21 striæ visible across the cell; each chloroplast with about 6 ridges and an axile row of 5–7 pyrenoids; terminal vacuoles with many moving granules.

Zygospore globose and smooth, often enveloped in a copious mucus.

Distance between apices (= length) 235–478 μ; breadth 22–53 μ; breadth of apices 10–14 μ; diam. of zygosp. 65 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W., N., and E. Yorks! Lancashire! (*Ralfs*). Cheshire (*Ralfs*). Leicester (*Roy*). Warwick (*Wills*). Herts (*Hassall*). Suffolk! Middlesex! Kent! (*Ralfs*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*).

WALES.—General and abundant (at 2,200 ft. on Glyder Fach)!

SCOTLAND.—General! (*Roy & Bissett*). Common in Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Londonderry! Down! Antrim!

Geogr. Distribution.—Generally distributed in Europe. Faeroes. Greenland. Spitzbergen. Nova Zembla. India. Ceylon. Burmah. Singapore. Java. Central China. Japan. New Zealand. East Africa. United States. Brazil.

Considering the wide distribution of this species it exhibits little variation. Specimens from different localities may vary in their comparative length and breadth and also in the relative breadth of the apices. Sometimes the apices are a little inflated, but this is not a common feature. The striolations vary from 13 to 17 in 20 μ. In many of the mountain forms the cell-wall is almost colourless. The curvature is somewhat variable but is never very great. In some forms the central portion of the cell is straight and the apices are considerably curved, but considering the large number of intermediate states the name "var. *orthonotum*," given to this form by Roy, is not warranted.

The striolations are not very strong and towards the extremities they become reduced in number, a character found in many striolated *Closteria*. This is brought about either by the gradual fading out of a few of the striolations or the fusion of some of them before they reach the apex. The cell-wall between the striolations is often minutely punctulate.

Forma **recta** West. (Pl. XIII, fig. 17.)

Closterium striolatum forma *recta* West, Alg. N. Wales, 1890, p. 285, t. 5, f. 23.

Cells straight and symmetrical around a longitudinal axis.

Length 216 μ; breadth 33 μ.

WALES.—Llyn Padarn, Carnarvonshire!

Lagerheim has suggested (Nuova Notarisia, II, p. 30) that this form is a species of *Penium*, but this is not so. Except for its straightness it is a typical *Cl. striolatum*.

11. **Closterium intermedium** Ralfs.

(Pl. XIV, figs. 1–5.)

Closterium intermedium Ralfs, Brit. Desm. 1848, p. 171, t. 29, f. 3 and f. 2 *h*; Arch. in Pritch. Infus. 1861, p. 749; Lund. Desm. Suec. 1871, p. 77; Cooke, Brit. Desm. 1886, p. 29, t. 11, f. 2; t. 15, f. 6; Gutw. Flor. Glon. Okolic Lwowa, 1891, p. 34; West, Alg. Eng. Lake Distr. 1892, p. 720; Roy & Biss. Scott. Desm. 1894, p. 245; Nordst. Index Desm. 1896, p. 148; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 55; Alg. N. Ireland, 1902, p. 24; Freshw. Alg. Ceylon, 1902, p. 137.

? *Cl. subjuncidum* De Not. Desm. Ital. 1867, p. 63, t. 7, f. 68.

Cl. striolatum b. *elongatum* Rabenh. Flor. Europ. Algar. III, 1868, p. 125; Kirchn. Alg. Schles. 1878, p. 139; Hansg. Prodr. Algenfl. Böhm. 1888, p. 242.

Cl. subdirectum West, Desm. Massachussetts, 1889, p. 17, t. 3, f. 16.

Arthrodia intermedia Kuntze, Revis. gen. plant. 1891, p. 884.

Cells of medium size, 12–15 times longer than their diameter, moderately curved, outer margin from 36° to 45° of arc, inner margin slightly concave, not tumid but sometimes straight in the median portion, gradually attenuated towards the apices, which are truncate with rounded angles; cell-wall pale yellow or yellowish-brown in colour, strongly striated, with 8–10 visible striæ across the cell; each chloroplast with 5 or 6 pyrenoids; terminal vacuoles with one large moving granule or a few smaller ones.

Zygospore globose and smooth.

Length 234–465 μ; breadth 16–31 μ; breadth of apices 10–11·5 μ; diam. of zygosp. 38–54 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W., N., and E. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Warwick (*Wills*). Surrey! Hants (*Roy*). Devon! (*Bennett*). Cornwall! (*Marquand*).

WALES.—Bettws-y-coed (*Roy*), Capel Curig! (*Cooke & Wills*), Glyder Fawr (*Roy*), near Dolbadarn Castle!, Llyn Padarn, Carnarvonshire! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Sutherland!, Ross, Inverness!, Nairn, Aberdeen, Kincardine, Forfar, Perth!, Stirling, Dumbarton, Argyll, Renfrew, Arran; zygospores from Fyvie, Aberdeen (*Roy & Bissett*). Kirkcudbright! Lewis, Harris, and Benbecula, Outer Hebrides! Orkneys!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Down! Armagh! Antrim!

Geogr. Distribution.—France. Germany. Austria. Poland. Portugal. Norway. Sweden. N. and S. Russia. Faeroes. Ceylon. Australia. United States. Brazil.

This species is easily distinguished from the succeeding one (*Cl. Ulna*) by its somewhat greater curvature, its greater attenuation towards the extremities, and its much coarser striolation. It is distinguished from *Cl. striolatum* by its proportionately narrower cells and by its fewer and coarser striæ.

The smallest forms we have observed were from Lough Akibbon, Donegal, Ireland:—length 190 μ; breadth 14 μ; breadth of apices 6 μ. In other respects they were absolutely typical.

Var. **hibernicum** West. (Pl. XIV, fig. 6.)

Closterium intermedium var. *hibernicum* West, New Brit. Freshw. Alg. 1894, p. 3, t. 1, f. 2; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 55.

? *Cl. intermedium* a. *typicum* Klebs, Desm. Ostpreuss. t. 2, f. 16.

A rather long variety with the median part of the cell straight and the apical portions somewhat suddenly incurved; with 9 visible striæ, which are rather stronger than in the typical form.

Length 290 μ; breadth 19 μ.

ENGLAND.—Terrington, N. Yorks! Puttenham Common and near Chapel Wood, Surrey!

IRELAND.—Westport, Mayo!

Var. **sculptum** Racib.

Closterium intermedium var. *sculptum* Racib. Desm. Nowe, 1889, p. 75, t. 7, f. 19.

A variety 15–17 times longer than the diameter, commonly with 9 visible striæ, each being composed of a series of oblong granules (2–3 μ in length).

Length 456–512 μ; breadth 30–32 μ; breadth of apices about 15 μ.

Distribution.—Bohemia.

The typical form of this variety has not been observed from the British Islands, but Turner has described a form of it.

Var. **sculptum** Racib. forma **eboracensis** Turner.

Closterium intermedium var. *sculptum* Racib. forma *eboracensis* Turner, Desm. Notes, 1893, p. 346, f. 17; West & G. S. West, Alga-fl. Yorks. 1900, p. 55.

This form differs from Raciborski's in the possession of dilated apices.

Length 410 μ; breadth 21·5 μ; breadth of apices 15 μ.

ENGLAND.—Strensall Common, N. Yorks (*W. B. Turner*).

12. **Closterium Ulna** Focke.

(Pl. XIV, figs. 7–9.)

Closterium Ulna Focke, Phys. Stud. 1847, p. 59, t. 3, f. 30; Nordst. Index Desm. 1896, p. 265; West & G. S. West, Alga-fl. Yorks. 1900, p. 55; Alg. N. Ireland, 1902, p. 24.

Closterium directum Arch. Descript. new Cosm., etc., 1862, p. 249, t. 12, f. 23 and 24; Rabenh. Flor. Europ. Algar. III, 1868, p. 127; Cooke, Brit. Desm. 1886, p. 18, t. 8, f. 3; Nordst. Freshw. Alg. N. Zeal. 1888, p. 69; West, Alg. W. Ireland, 1892, p. 120; Roy & Biss. Scott. Desm. 1894, p. 244; Borge, Süssw. Chlor. Archang. 1894, p. 14; Nordst. Index Desm. 1896, p. 110; West & G. S. West, Alg. S. England, 1897, p. 482.

Cl. striolatum var. *Ulna* Jacobs. Desm. Danem. 1875, p. 175.

Cl. intermedium b. *directum* Klebs, Desm. Ostpreuss. 1879, p. 16, t. 2, f. 17.

Arthrodia directa Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, 16–20 times longer than their diameter, very slightly curved, outer margin from 15° to 23° of arc, inner margin not tumid, almost parallel to the outer margin, very slightly attenuated to the apices, which are truncate; cell-wall colourless or pale yellow, very finely striated, with 14–20 striæ visible across the cell; each chloroplast with 5 or 6 indistinct ridges and a median series of 6 or 7 pyrenoids; terminal vacuoles generally with one large moving granule.

Zygospore unknown.

Length 220–480 μ; breadth 11–22 μ; breadth of apices 8·5–12 μ.

England.—Cocket Moss, Giggleswick Common, bog two miles S. of Clapham, W. Yorks! Sutton Park, Warwick (*Wills*). Esher Common and near Chapel Wood, Surrey!

Wales.—Capel Curig, Moel Siabod, and Glyder Fach, Carnarvonshire!

Scotland.—Sutherland!, Ross!, Inverness!, Aberdeen, Kincardine, Forfar, Perth!, Argyll, Arran (*Roy & Bissett*). Harris and Lewis, Outer Hebrides!

Ireland.—Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria. Norway. Sweden. Denmark. Russia. Poland. Faeroes. India. Java. New Zealand. United States.

Some algologists have confused this species with *Cl. intermedium* Ralfs, but those observers cannot have seen both species. *Cl. Ulna* is much less curved than *Cl. intermedium*; it is rather more elongate and is less attenuated towards the extremities. The striolations of *Cl. Ulna* are exceedingly delicate and from 14 to 20 are visible across the cell, whereas those of *Cl. intermedium* are very strong and only 8 to 10 are visible.

13. **Closterium juncidum** Ralfs.

(Pl. XIV, figs. 10–14.)

Closterium juncidum Ralfs, Brit. Desm. 1848, p. 172, t. 29, f. 6; Arch. in Pritch. Infus. 1861, p. 749; Rabenh. Flor. Europ. Algar. III, 1868, p. 127; Delp. Desm. subalp. 1877, p. 115, t. 17, f. 11–14; Kirchn. Alg. Schles. 1878, p. 137; Cooke, Brit. Desm. 1886, p. 30, t. 13, f. 7; Hansg. Prodr. Algenfl. Böhm. 1888, p. 178; Roy & Biss. Scott. Desm. 1894, p. 245; Nordst. Index Desm. 1896, p. 151; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 56; Alg. N. Ireland, 1902, p. 24.

Cl. intermedium c. *juncidum* Klebs, Desm. Ostpreuss. 1879, p. 16, t. 2, f. 5 *b*.

Arthrodia juncida Kuntze, Revis. gen. plant. 1891, p. 883.

Cells elongate and slender, 24–40 times longer than their diameter, straight in the median portion and with the margins parallel, towards the apices slightly incurved and attenuated; apices obtusely rounded; cell-wall brown or reddish-brown, sometimes only pale yellow, striated, with 5–7 visible striæ across the cell, and with 4–7 pyrenoids in each chloroplast; terminal vacuoles elongated, with several moving granules.

Zygospore globose and smooth.

Length 110–330 μ; breadth 4·5–8 μ; diam. zygosp. 22–24 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W., N., and E. Yorks! Lancashire! Cheshire (*Ralfs*). Leicester (*Roy*). Warwick (*Wills*). Essex! Sussex! (*Ralfs*). Surrey! Hants! Cornwall! (*Ralfs*); zygospores from Tintagel!

WALES.—General in Carnarvonshire (at 2,200 ft. on Glyder Fach)! Dolgelly, Merioneth!

SCOTLAND.—General! (*Roy & Bissett*). Zygospores from Fyvie, Aberdeen (*Roy*); and from Glas Meal, Perth! General in the Outer Hebrides! Shetlands!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Down! Antrim!

Geogr. Distribution.—General in Europe. Greenland. India. Java. Australia. East Africa. United States.

In the outline of its cells this species very much resembles *Cl. gracile* Bréb.

Var. **brevior** Roy. (Pl. XIV, figs. 15, 16.)

Cl. juncidum var. β Ralfs, Brit. Desm. 1848, p. 172, t. 29, f. 7.

Cl. juncidum var. *brevior* et robustior, Rabenh. Flor. Europ. Algar. III, 1868, p. 127.

Cl. juncidum var. *brevior* Roy, in Journ. Bot. 1890, p. 336; Borge Chlor. Norska Finmark. 1892, p. 14.

Cells relatively broader than in the typical form, 12–20 times longer than their diameter.

Length 150–275 μ; breadth 12–14 μ; diam. zygosp. 40–44 μ.

ENGLAND.—Midhurst, Sussex (*Jenner & Ralfs*).

WALES.—Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Much rarer than the typical form.

Geogr. Distribution.—France. Austria. Finland. United States.

The striolations of this variety are sometimes very obscure and liable to be overlooked.

Var. **elongatum** Roy & Biss.

Cl. juncidum var. *elongatum* Roy & Biss. Scott. Desm. 1894, p. 245.

Cells rather large, about 36 times longer than their diameter.

Length 355–400 μ; breadth 11·2 μ.

Scotland.—General (*Roy & Bissett*).

We have never seen this variety from any part of the British Islands, although Roy appears to have found it frequently in Scotland.

Section B.

14. **Closterium Dianæ** Ehrenb.

(Pl. XV, figs. 1–6.)

? *Closterium ruficeps* Ehrenb. Entwick. Lebends. d. Infus. 1832, p. 67.

Cl. Dianæ Ehrenb. Infus. 1838, p. 92, t. 5, f. xvii, 1–6; Menegh. Synops. Desm. 1840, p. 232; Hass. Brit. Freshw. Alg. 1845, p. 371, t. 84, f. 5; Ralfs, Brit. Desm. 1848, p. 168, t. 28, f. 5; Arch. in Pritch. Infus. 1861, p. 748; Rabenh. Flor. Europ. Alg. III, 1868, p. 133; Cooke, Brit. Desm. 1886, p. 26, t. 13, f. 3; ? West, Alg. W. Ireland, 1892, p. 122; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 104; West & G. S. West, Alg. S. England, 1897, p. 481; Some Desm. U.S. 1898, p. 284; Alga-fl. Yorks. 1900, p. 48; Alg. N. Ireland, 1902, p. 23.

Cl. acuminatum Kütz. Phyc. germ. 1845, p. 130; Rabenh. Flor. Europ. Algar. III, 1868, p. 133; Wittr. Gotl. Öl. sötv. Alg. 1872, p. 64, t. 4, f. 18; Wolle, Desm. U.S. 1884, p. 44; De Toni, Syll. Alg. 1889, p. 840.

Cl. Dianæ a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 11, t. 1, f. 10 *a*, f. 13 *h*.

Arthrodia Dianæ Kuntze, Revis. gen. plant. 1891, p. 883.

A. acuminata Kuntze, l.c.

Cells of medium size, usually 10–12 times longer than their diameter, strongly curved, outer margin about 112°–130° of arc, inner margin scarcely or very slightly tumid, gradually and gracefully attenuated towards the apices, which are obtusely rounded; dorsal margin at each apex obliquely truncate and thickened; cell-wall smooth and of a reddish-brown colour; chloroplasts obscurely ridged, containing a single series of five or six pyrenoids; terminal vacuoles with many moving granules.

Zygospore globose and smooth.

Distance between apices 270–380 μ; breadth 16–36 μ; breadth of apices about 6 μ; diam. zygosp. 36–52 μ.

ENGLAND.—Cumberland! Westmoreland (at 2,400 ft. on Helvellyn)! W., N., and E. Yorks (zygosp. from Markington, W. Yorks)! Lancashire! Cheshire (*Ralfs*). Lincolnshire! Suffolk! Essex! Cambridge! Warwick (*Wills*). Surrey! Sussex (*Ralfs*). Hants! (*Bennett*). Devon! (*Bennett*). Cornwall! (*Ralfs*).

WALES.—Fairly general in the north!

SCOTLAND.—General! Zygospores from Coul in Ross; between Loch Kinnord and Cambus O'May, Aberdeen; Loch Lundie, Perth (*Roy & Bissett*). General in the Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Mayo! Galway! Kerry! Donegal! Dublin and Wicklow (*Archer*). Antrim! Down!

Geogr. Distribution.—France. Germany. Austria. Galicia. Hungary. Italy. Portugal. Norway. Sweden. Denmark. Bornholm. Finland. N., S., and Central Russia. Faeroes. Iceland. Nova Zembla. Spitzbergen. Greenland. Siberia. Central China. Japan. Ceylon. Siam. Java. Australia. New Zealand. Central and E. Africa. United States. W. Indies. Brazil. Uruguay.

Some forms of this species have been noticed in which the cell-wall was finely punctate, and others in which it was distinctly granulate. The granules were large, but only of slight elevation.

Var. **arcuatum** (Bréb.) Rabenh. (Pl. XV, figs. 21, 22.)

Closterium arcuatum Bréb. in Ralfs' Brit. Desm. 1848, p. 219; Bréb. Liste Desm. 1856, p. 149, t. 2, f. 38; Lund. Desm. Suec. 1871, p. 80; Roy & Biss. Scott. Desm. 1894, p. 243; Nordst. Index Desm. 1896, p. 50; West & G. S. West, Alga-fl. Yorks. 1900, p. 49.

Cl. Dianæ var. *arcuatum* Rabenh. Flor. Europ. Alg. III, 1868, p. 133; Hansg. Prodr. Algenfl. Böhm. 1888, p. 181; Gutw. Flor. Glon. Okolic Tarnopola, 1894, p. 80; Nordst. Index Desm. 1896, p. 105.

About 10 times longer than the diameter, slightly smaller and more strongly curved than the typical form, outer margin 140°–152° of arc; cell-wall of a pale yellow colour.

Distance between apices 129–290 μ; breadth 18–25 μ; breadth of apices 6–7 μ; diam zygosp. 27–29 μ.

England.—Skipwith Common, E. Yorks! Delamere, Cheshire (*Roy*). Enbridge Lake, Hants (*Roy*).

Wales.—Capel Curig, Carnarvonshire (*Roy*).

Scotland.—Sutherland, Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth, Fife; zygospores from Fyvie, Aberdeen, and Cammie, Kincardine (*Roy*).

Geogr. Distribution.—France. Germany. Austria. Norway. Sweden. India. New Zealand. E. Africa.

This variety differs from typical *Cl. Dianæ* only in its greater degree of curvature. The apices of the cells are identical in character with those of the type form, and the cell-wall is faintly coloured. The zygospores are globose and smooth. It is very rarely met with even though typical *Cl. Dianæ* is abundant in many districts.

15. **Closterium Pseudodianæ** Roy.

(Pl. XV, figs. 7, 8.)

Closterium Pseudodianæ Roy, Desm. Alford District, 1890, p. 201; Roy & Biss. Scott. Desm. 1894, p. 248, t. 1, f. 4 (1893); Nordst. Index Desm. 1896, p. 208; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 49; Lütkem. Desm. Millstättersees, 1900, p. 5.

Cells of medium size, 14–20 (commonly 16–18) times longer than their diameter, moderately curved, outer margin 78°–88° of arc, inner margin almost straight in the median part of the cell, gradually attenuated towards the apices, which are narrow and obtuse, with a slight thickening on the dorsal margin; cell-wall smooth, colourless, or yellowish-brown; chloroplasts obscurely ridged, with a single series of 5 or 6 pyrenoids; terminal vacuoles with several moving granules.

Zygospore unknown.

Distance between apices 192–253 μ; breadth 12–14 μ; breadth of apices 2·5–3 μ.

England.—Roundhay Park, Leeds; Cocket Moss, near Giggleswick, W. Yorks! Delamere, Cheshire (*Roy*). Thursley Common, Surrey!

Scotland.—Ross, Aberdeen, Kincardine, Forfar, Perth, Argyll (*Roy*). Loch Shin, Loch Inver, and Rhiconich, Sutherland! Skye in Inverness!

Ireland.—Adrigole and Glen Caragh, Kerry!

Geogr. Distribution.—Austria. Ceylon. Madagascar. E. Africa.

This species is distinguished from *Cl. Dianæ* by its curvature and its smaller size. The apices are also relatively narrower than in *Cl. Dianæ,* although according to Roy they possess the oblique thickening found in that species. This character is, however, variable in *Cl. Pseudodianæ,* and is often entirely absent.

It is a very rare species of the genus except in certain areas of the north-west of Scotland. The Austrian specimens recorded by Lütkemüller are of somewhat smaller size and have broader apices.

16. **Closterium parvulum** Näg.

(Pl. XV, figs. 9–12.)

Closterium parvulum Näg. Gatt. einz. Alg. 1849, p. 106, t. 6 C, f. 2 (in part); De Bary, Conj. 1858, p. 41, 42, 48–51, t. 5, f. 14–23; Rabenh. Flor. Europ. Alg. III, 1868, p. 134; Kirchn. Alg. Schles. 1878, p. 141; Wolle, Desm. U. S. 1884, p. 45, t. 7, f. 7, t. 8, f. 16; Hansg. Prodr. Algenfl. Böhm. 1888, p. 182; De Toni, Syll. Alg. 1889, p. 841; Lütkem. Desm. Attersees. 1893, p. 543; Roy & Biss. Scott. Desm. 1894, p. 247; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 151; Nordst. Index Desm. 1896, p. 196; West & G. S. West, Alg. S. England, 1897, p. 481; G. S. West, Alga-fl. Cambr. 1899, p. 112; West & G. S. West, Alga-fl. Yorks. 1900, p. 49; Alg. N. Ireland, 1902, p. 23; Scott. Freshw. Plankton, I, 1903, p. 525.

Arthrodia parvula Kuntze, Revis. gen. plant. 1891, p. 884.

Cells small, 9–15 times longer than their diameter, strongly curved, outer margin 120°–140° of arc, inner margin not tumid, gradually attenuated to the apices, which are acutely rounded; cell-wall smooth and colourless (rarely yellowish-brown); chloroplasts with about five ridges and a single series of 3–6 pyrenoids; terminal vacuoles with several moving granules.

Zygospore ellipsoid or subglobose, smooth.

Distance between apices 96–121 μ; breadth 11–14·5 μ; breadth of apices about 1·5 μ; length of zygospore 30–40 μ; breadth of zygospore 26–34·5 μ.

ENGLAND.—Cumberland! Westmoreland (with zygosp.)! W. (with zygosp.), N. (with zygosp.), and E. Yorks! Lancashire! Essex! Cambridge! Middlesex! Surrey (with zygosp.)! Kent! Hants! Devon! Cornwall (with zygosp.)!

WALES.—General in Carnarvonshire (up to 3,000 ft. on Snowdon)! Merioneth!

SCOTLAND.—Ross, Inverness!, Aberdeen (with zygosp.), Kincardine, Perth!, Stirling, Fife (*Roy & Bissett*). Dumfries! Kirkcudbright! Ayr (with zygosp.)! Caithness! Sutherland! General in the Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Donegal! Mayo! Galway! Kerry! Londonderry! Armagh! Wicklow!

Geogr. Distribution.—France. Germany. Switzerland. Austria. Galicia. Hungary. Spain. Norway. Sweden. Denmark. Finland. N., S., and Central Russia. Nova Zembla. Greenland. Siberia. Japan. Ceylon. Siam. Sumatra. Java. Samoa. Australia. Central and E. Africa. United States. Brazil. Ecuador. Patagonia.

This Desmid is not more than about half the size of *Cl. Dianæ* and is of a stouter aspect. The apices are also rather more acute. Nägeli described the cell-wall as being very finely striated, but as we invariably find it perfectly smooth and colourless, we are inclined to believe that he included more than one species in his observations.

Var. **angustum** West & G. S. West. (Pl. XV, figs. 13, 14.)

Cl. parvulum var. *angustum* West & G. S. West, Notes Alg. II, 1900, p. 290, t. 412, f. 8; West & G. S. West, Alga-fl. Yorks. 1900, p. 49; Borge, Alg. erst. Regnell. Exped., II, Desmid. 1903, p. 79.

Cells a little smaller and narrower than in the typical form.

Distance between apices 94–102 μ; breadth 7·7 μ.

ENGLAND.—Pilmoor, N. Yorks!

Geogr. Distribution.—Brazil. Paraguay.

17. **Closterium Jenneri** Ralfs.

(Pl. XV, figs. 23–25.)

Closterium Jenneri Ralfs, Brit. Desm. 1848, p. 167, t. 28, f. 6; Arch. in Pritch. Infus. 1861, p. 748; Rabenh. Flor. Europ. Algar. III, 1868, p.

134; Kirchn. Alg. Schles. 1878, p. 140; Wolle, Desm. U.S. 1884, p. 44, t. 7, f. 5; Cooke, Brit. Desm. 1886, p. 24, t. 13, f. 4; Hansg. Prodr. Algenfl. Böhm. 1888, p. 242; De Toni, Syll. Alg. 1889, p. 843; West, Alg. W. Ireland, 1892, p. 122; Börg. Ferskv. alg. Östgrönl. 1894, p. 11, t. 1, f. 2; Roy. & Biss. Scott. Desm. 1894, p. 245; Nordst. Index Desm. 1896, p. 150; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 49; Alg. N. Ireland, 1902, p. 24; Scott. Freshw. Plankton, I, 1903, p. 525.

Cl. Dianæ c. *Jenneri* Klebs, Desm. Ostpreuss. p. 12, t. 1, f. 12 *b*, f. 13 *a*.

Arthrodia Jenneri Kuntze, Revis. gen. plant. 1891, p. 883.

Cells small, 8–12 times longer than their diameter, strongly curved, more so towards the extremities than in the median portion, outer margin 150°–175° of arc, inner margin not tumid, sometimes almost straight for a short distance in the middle, gradually attenuated to the apices, which are obtusely rounded; cell-wall smooth and colourless; chloroplasts with four or six ridges, and with 1–6 pyrenoids in a single series; terminal vacuoles with one or two large moving granules.

Zygospore oblong-ellipsoid, smooth.

Distance between apices 48–94 μ; breadth 7–14 μ; breadth of apices 2·5–5·5 μ; length of zygosp. 30–37 μ; breadth of zygosp. 20–30 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W., N., and E. Yorks! Lancashire! Leicester (*Roy*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*).

WALES.—General in Carnarvonshire! Ffestiniog, Merioneth! Holyhead, Anglesey!

SCOTLAND.—Sutherland!, Ross, Aberdeen, Kincardine, Forfar!, Perth!, Argyll, Arran (*Roy & Bissett*). Ayr! Dumfries! Lewis and N. Uist, Outer Hebrides! Shetlands!

IRELAND.—Donegal! Mayo! Galway! Kerry! Down! Antrim! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Galicia. Hungary. Italy. Spain. Norway. Sweden. Bornholm. N. and S. Russia. Faeroes. Nova Zembla. Greenland. Siam. Java. Central and E. Africa. Azores. United States. Brazil.

Cl. Jenneri is easily distinguished from *Cl. parvulum* by its stronger curvature and by its more robust extremities. From

Cl. Venus it is distinguished by the straighter median portion of the cell, by the thicker and more rounded apices, and by its proportionately greater length. It also differs from both these species in the nature of the terminal vacuoles, which contain only one or two large moving granules.

Var. **robustum** G. S. West. (Pl. XV, figs. 26, 27.)

Cl. Jenneri var. *robustum* G. S. West, Alga-fl. Cambr. 1899, p. 112, t. 396, f. 9; West & G. S. West, Alga-fl. Yorks. 1900, p. 50; West & G. S. West, Alg. N. Ireland, 1902, p. 24 [erroneously reported as "var. *crassum*"].

Stouter than the typical form, scarcely attenuated towards the broadly obtuse apices.

Distance between apices 61–77 μ; breadth 12·5 μ; breadth of apices about 6–7·5 μ.

ENGLAND.—Pilmoor, N. Yorks! Twenty-foot River, between March and Guyhirne, Cambridge!

IRELAND.—North of Newcastle, Down!

18. **Closterium incurvum** Bréb.

(Pl. XV, figs. 28–30.)

Closterium incurvum Bréb. Liste Desm. 1856, p. 150, t. 2, f. 47; Arch. in Pritch. Infus. 1861, p. 748; Rabenh. Flor. Europ. Algar. III, 1868, p. 135; Delp. Desm. subalp. 1877, p. 102, t. 17, f. 22–27; De Toni, Syll. Alg. 1889, p. 843; Roy & Biss. Scott. Desm. 1894, p. 245; Nordst. Index Desm. 1896, p. 144; West & G. S. West, Alga-fl. Yorks. 1900, p. 50; Alg. N. Ireland, 1902, p. 24.

Cl. Leibleinii Kütz. b. *minus* Rabenh. Flor. Europ. Algar. III, 1868, p. 132.

Cl. Dianæ e. *incurvum* Klebs, Desm. Ostpreuss. 1879, p. 12, t. 1, f. 14 *a*, *b*.

Cells very small, 5–7 times longer than their diameter, strongly curved, outer margin about 180° of arc, inner margin not tumid, strongly attenuated towards the apices, which are acute; cell-wall smooth and colourless; chloroplasts with several small pyrenoids in one series; terminal vacuoles with several small moving granules.

Zygospore globose and smooth.

Distance between apices 52–64 μ; breadth 10·5–14 μ.

ENGLAND.—Pilmoor, N. Yorks! Delamere, Cheshire

(*Roy*). Enbridge Lake, Hants (*Roy*). Cornwall (*Marquand*).

WALES.—Capel Curig (*Roy*).

SCOTLAND.—Sutherland, Ross, Inverness, Nairn, Aberdeen, Kincardine, Forfar, Perth, Stirling, Dumbarton, Fife (*Roy & Bissett*). Shetlands!

IRELAND.—Lough Akibbon, Donegal! Carrantuohill, Kerry!

Geogr. Distribution.—France. Galicia in Austria. Italy. Sweden. Ceylon. Australia (var.). E. Africa.

Some specimens of this species possess a very slight depression or concavity on the outer margin close to the apex. It is a rare Desmid.

19. **Closterium Venus** Kütz.

(Pl. XV, figs. 15–20.)

Closterium Venus Kütz. Phyc. germ. 1845, p. 130; Ralfs, Brit. Desm. 1848, p. 220, t. 35, f. 12; Kütz. Spec. Alg. 1849, p. 164; Rabenh. Flor. Europ. Algar. III, 1868, p. 134; Wolle, Desm. U.S. 1884, p. 44, t. 7, f. 6; Hansg. Prodr. Algenfl. Böhm. 1888, p. 182; De Toni, Syll. Alg. 1889, p. 840; West, Alg. W. Ireland, 1892, p. 123; Eichler & Gutw. Nonn. spec. alg. nov. 1894, p. 163, t. 4, f. 3; Roy & Biss. Scott. Desm. 1894, p. 249; Nordst. Index Desm. 1896, p. 267; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 50; Alg. N. Ireland, 1902, p. 23; Scott. Freshw. Plankton I, 1903, p. 525.

Cl. Dianæ a. *Venus* Klebs, Desm. Ostpreuss. 1879, p. 12, t. 1, f. 14 *c, e*.

Arthrodia Venus Kuntze, Revis. gen. plant. 1891, p. 884.

Closterium trochiscosporum West & G. S. West, New and Int. Freshw. Alg. 1896, p. 151, t. 3, f. 16–20; West & G. S. West, Alg. S. England, 1897, p. 481.

Cells small, 8–9 times longer than their diameter, strongly curved, outer margin 150°–160° of arc, inner margin not tumid, gradually attenuated to the apices, which are acute or acutely rounded; cell-wall smooth, colourless, or more rarely yellowish-brown; chloroplasts ridged, with two pyrenoids (rarely only one); terminal vacuoles large, with a number of moving granules.

Zygospore oblong-rectangular with rounded angles, shorter sides retuse, longer sides convex and inflated in the middle; often twisted, the two angles at one end of the zygospore being disposed in a plane at right angles to that containing the two angles of the opposite end.

Distance between apices 51–81 μ; breadth 7–10·5 μ; length of zygospore 23–28·5 μ; breadth of zygosp. 18–22 μ.

ENGLAND.—Westmoreland! W., N., and E. Yorks! Lancashire! Cheshire (*Roy*). Leicester (*Roy*). Cambridge! Oxford (zygosp. from near Goring)! Essex! Surrey! Hants! Cornwall (*Marquand*).

WALES.—Fairly general!

SCOTLAND.—General! (*Roy & Bissett*). General in Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Donegal! Galway! Kerry! Down! Armagh! Antrim! Lough Neagh! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Norway. Sweden. N. Russia. Faeroes. Nova Zembla. Greenland. Siberia. Central China. Japan. Ceylon. Burmah. Siam. New Zealand. Central Africa. Azores. United States. Brazil. Patagonia.

The curvature of *Cl. Venus* distinguishes it from *Cl. parvulum*, and it is invariably of smaller dimensions. As a rule the apices are slightly more attenuated than those of *Cl. parvulum*, and there are rarely more than two pyrenoids in each chloroplast.

The curvature is almost the same as that of *Cl. Jenneri*, but the latter is a larger species of stouter aspect, with much thicker apices. The chloroplasts and terminal vacuoles are also different from those of *Cl. Jenneri*.

Cl. Venus has a very characteristic zygospore, which is at once sufficient to separate it as a well-marked species from all other small, strongly curved *Closteria*.

20. **Closterium calosporum** Wittr.

(Pl. XVI, figs. 1–4.)

Closterium calosporum Wittr. Skandinav. Desm. 1869, p. 23, t. i, f. 11; Lund. Desm. Suec. 1871, p. 81; Cooke, Brit. Desm. 1886, p. 27, t. 13, f. 6; De Toni, Syll. Alg. 1889, p. 842; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 71; West & G. S. West, Alg. N. Ireland, 1902, p. 23; Freshw. Alg. Ceylon, 1902, p. 140.

Arthrodia calospora Kuntze, Revis. gen. plant. 1891, p. 883.

Cells small, 8–10 times longer than their diameter, strongly curved, outer margin 125°–135° of arc, inner margin not tumid, gradually attenuated to the apices, which are subacute or acutely rounded; cell-wall smooth and colourless; chloroplasts with a single series of about four pyrenoids.

Zygospore globose, furnished with mammillate or conical projections, nine or ten of which show in the margin.

Distance between apices 77–108 μ; breadth 9–12 μ; diam. zygosp. without projections 18–25 μ, with projections 25–32 μ.

ENGLAND.—Delamere, Cheshire (*Roy*). Enbridge Lake, Hants (*Roy*).

WALES.—Bettws-y-coed and Glyder Fawr, Carnarvonshire (*Roy*).

SCOTLAND.—General; zygosp. from near Dinnet, Aberdeen, and Glen Dye, Kincardine (*Roy & Bissett*). Harris, Outer Hebrides! Orkneys!

IRELAND.—Dungloe, Doocharry Bridge, near Glenties, and Lough Machugh, Donegal! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Galicia in Austria. Sweden. Poland. N. Russia. Nova Zembla. Ceylon. Siam. Brazil (var.). Paraguay (var.).

This species differs very little in its sterile condition from *Cl. parvulum*, having the same curvature but being a little smaller. The cell-wall was described by Wittrock as very delicately striated, but we doubt whether these striations have ever been detected since they were originally described. We have, therefore, described the cell-wall as "smooth." It is a species which has most probably been greatly overlooked, chiefly on account of its close resemblance to *Cl. parvulum*, but when found in the conjugated state the zygospores are eminently characteristic.

Forma **major** West and G. S. West. (Pl. XVI, figs. 5, 6.)

Cl. calosporum forma *major* West and G. S. West, New and Int. Freshw. Alg. 1896, p. 152, t. 3, f. 25, 26; Nordst. Index Desm. 1896, p. 275; West & G. S. West, Alg. S. England, 1897, p. 481.

Cl. calosporum var. *galiciense* Gutw. Nonn. Alg. Nov. 1896, p. 9, t. 6, f. 21.

Cells larger than in the typical form; cell-wall smooth; zygospores with slightly longer conical projections, the bases of which are a little more remote.

Distance between apices 140–161 μ; breadth 14–17 μ; diam. zygosp. without projections 29·5–37 μ, with projections 38–51 μ.

ENGLAND.—Near Goring, Oxfordshire (with zygosp.)!

Geogr. Distribution.—Galicia in Austria.

The specimens described by Gutwinski from Poland, under the name of "*Cl. calosporum* var. *galiciense*," were somewhat smaller than the British forms. His dimensions were:—Distance between apices 112–116 μ; breadth 13 μ; diam. zygosp. without projections 24 μ; length of projections 6·4 μ.

21. **Closterium eboracense** Turner.

(Pl. XVI, figs. 7, 8.)

Closterium Cucumis Wolle, Desm. U. S. 1884, p. 40, t. 6, f. 17, 18. [Not *Cl. cucumis* Ehrenb. 1843.]

Cl. eboracense Turn. in Cooke's Brit. Desm. 1886, p. 37, t. 65, f. 1; Turn. in Trans. Leeds Nat. Club, 1886, I, t. 1, f. 16; De Toni, Syll. Alg. 1889, p. 844; Roy & Biss. Scott. Desm. 1894, p. 244; West & G. S. West, Alga-fl. Yorks. 1902, p. 50.

Arthrodia eboracense Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, robust, about 5 times longer than their diameter, outer margin about 120° of arc, inner margin concave, not tumid, gradually attenuated to the apices, which are thick and broadly rounded; cell-wall smooth and colourless; chloroplasts with eight distinct ridges and a single series of about five pyrenoids; terminal vacuoles large, with a number of moving granules.

Zygospore unknown.

Distance between apices (length) 140–206 μ; breadth 35–49 μ; breadth near apices 11–15 μ.

ENGLAND.—Campsall, Doncaster, and Chapel-Allerton, W. Yorks (*Turner*). Mickle Fell, N. Yorks!

SCOTLAND.—Little Don, Haughton, Aberdeen (*Roy & Bissett*).

22. **Closterium Leibleinii** Kütz.

(Pl. XVI, figs. 9–14.)

Closterium Leibleinii Kütz. Syn. Diat. 1834, p. 596, t. 18, f. 79; Menegh. Synops. Desm. 1840, p. 232; Ralfs, Brit. Desm. 1848, p. 167, t. 28, f. 4; Kütz. Spec. Alg. 1849, p. 163; Arch. in Pritch. Infus. 1861, p. 748, t. 2, f. 1, 5; Rabenh. Flor. Europ. Algar. III, 1868, p. 132; Wolle, Desm. U. S. 1884, p. 46, t. 7, f. 13, 14, 20; Cooke, Brit. Desm. 1886, p. 25, t. 13, f. 1; De Toni, Syll. Algar. 1889, p. 846; West, Alg. W. Ireland, 1892, p. 122; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 156; West & G. S. West, Alg. S. England, 1897, p. 481; G. S. West, Alga-fl. Cambr. 1899, p. 112; West & G. S. West, Alga-fl. Yorks. 1900, p. 50; Alg. N. Ireland, 1902, p. 23.

Cl. Leibleinii var. β Ralfs, Brit. Desm. 1848, p. 167.

Cl. moniliferum Ehrenb. forma A. *Leibleinii* Reinsch, Algenfl. Frank. 1867, p. 190.

Cl. moniliferum Ehrenb. forma *Leibleiniana* Jacobs. Desm. Danem. 1875, p. 170.

Cl. moniliferum Ehrenb. b. *Leibleinii* Klebs, Desm. Ostpreuss. 1879, p. 9, t. 1, f. 7.

Arthrodia Leibleinii Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, 6–8 times longer than their diameter, strongly curved, outer margin 135°–190° of arc, inner margin strongly concave, slightly tumid in the median part, gradually attenuated towards the apices, which are acutely rounded; cell-wall smooth and colourless, more rarely straw-colour or yellowish-brown; chloroplasts with about six ridges and a median row of 3–8 pyrenoids; terminal vacuoles large, with a number of moving granules.

Zygospore subglobose and smooth.

Distance between apices 107–202 μ; breadth 17–37 μ; diam. zygosp. 40–50 μ.

England.—Westmoreland! (*Bissett*). W., N., and E. Yorks! Lancashire! (*Ralfs*). Cheshire (*Ralfs*). Leicester (*Roy*). Essex! Cambridge! Oxford (zygosp. from near Goring)! Warwick (*Wills*). Gloucester! (*Ralfs*). Middlesex! Surrey! (*Ralfs*). Sussex (*Ralfs*). Hants! Devon! Cornwall! (*Ralfs*); zygosp. from Penzance (*Joshua*).

Wales.—General!

Scotland.—Common!; frequently in conjugation (*Roy & Bissett*). Lewis, Outer Hebrides! Shetlands!

Ireland.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Down! Lough Neagh! Antrim!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary and Bosnia. Italy. Spain. Portugal. Norway. Sweden. Denmark. N. and S. Russia. Faeroes. Iceland. Nova Zembla. Greenland. Siberia. Japan. India (var.). Ceylon. Samoa. Australia. W., Central, and E. Africa. Madagascar. United States. W. Indies. Brazil. Argentina. Uruguay. Patagonia.

Cl. Leibleinii is an abundant and somewhat variable species, exhibiting a considerable range both with regard to its size and its curvature. The apices are often more or less suddenly narrowed and almost subacuminate. Some of the American specimens reach a much larger size than any met with in Europe. The ventral inflation, which is one of its primary characters, varies much in the degree of its prominence, and the cell-wall occasionally becomes tinted. There are, however, too many intermediate states to discriminate with any degree of accuracy between these several forms.

It is distinguished from *Cl. moniliferum* by its greater curvature, its much more attenuated apices, and its smaller size. Perhaps *Cl. moniliferum* var. *minus* Kütz. (= *Cl. ornatum* Rabenh.) is really a form of *Cl. Leibleinii.*

23. **Closterium moniliferum** (Bory) Ehrenb.

(Pl. XVI, figs. 15, 16.)

Lunulina monilifera Bory, 1824.
Closterium moniliferum (Bory) Ehrenb. Infus. 1838, p. 91, t. 5, f. xvi (in part); Menegh. Synops. Desm. 1840, p. 232; Hass. Brit. Freshw. Alg. 1845, p. 370, t. 87, f. 2; Ralfs, Brit. Desm. 1848, p. 166, t. 28, f. 3; Kütz. Spec. Algar. 1849, p. 163; Näg. Gatt. einz. Alg. 1849, p. 106, t. 6, C, f. 1; Arch. in Pritch. Infus. 1861, p. 748; Rabenh. Flor. Europ. Algar. III, 1868, p. 131; Lund. Desm. Suec. 1871, p. 80, t. 5, f. 14; Wolle, Desm. U. S. 1884, p. 45, t. 7, f. 15; Cooke, Brit. Desm. 1886, p. 24, t. 12, f. 3; Hansg. Prodr. Algenfl. Böhm. 1888, p. 182, f. 108; De Toni, Syll. Alg. 1889, p. 845; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 173; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 50; Alg. N. Ireland, 1902, p. 23.
Cl. moniliferum a. *genuinum* Kirchn. Alg. Schles. 1878, p. 141.
Cl. moniliferum a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 9, t. 1, f. 8 *b*.
Cl. Leibleinii Kütz. var. *curtum* West, Desm. Mass. 1889, p. 17, t. 2, f. 8.
Arthrodia monilifera Kuntze, Revis. gen. plant. 1891, p. 883.
? *Closterium galiciense* Gutw. Nonn. Alg. Nov. 1896, p. 39, t. 2, f. 18.

Cells of medium size, stout, 6–8 times longer than their diameter, moderately curved, outer margin 100°–110° of arc, inner margin with a distinct inflation in the middle, uniformly narrowed to the apices, which are obtusely rounded; cell-wall smooth and colourless; chloroplasts with distinct ridges (about six in number) and with a single series of 6 or 7 pyrenoids; terminal vacuoles with numerous moving granules.

Zygospore ellipsoid and smooth, with an outer mucous, lamellose coat.

Distance between apices (length) 222–370 μ; breadth 33–50 μ; breadth of apices 8–11 μ.

ENGLAND.—Cumberland! Westmoreland (at 2,400 ft. on Helvellyn)! (*Ralfs*). W., N., and E. Yorks! Lancashire (*Ralfs*). Leicester (*Roy*). Lincoln! Norfolk! Essex! Cambridge! Gloucester! (*Ralfs*). Middlesex! (*Hassall*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Kent! Hants! Devon! Cornwall! (*Ralfs*).

WALES.—Yr Orsedd!, Bethesda!, Snowdon!, and Capel Curig (*Cooke & Wills*), Carnarvonshire. Llyn Coron, Anglesey! Ffestiniog, Merioneth!

SCOTLAND.—Caithness, Ross, Inverness!, Aberdeen!, Kincardine!, Forfar!, Perth!, Fife (*Roy & Bissett*). Shetlands!

IRELAND.—Donegal! Mayo! Kerry! Wicklow! (*Archer*). Down! Antrim!

Geogr. Distribution.—France. Belgium. Germany. Switzerland. Galicia in Austria. Hungary and Bosnia. Italy. Portugal. Norway. Sweden. Denmark. Bornholm. N. and S. Russia. Poland. Faeroes. Iceland. China. Japan. Ceylon. New Zealand. Central Africa. United States. Brazil. Argentina. Uruguay. Patagonia.

This species is distinguished from *Cl. Leibleinii* by its lesser curvature, its broader and more rounded apices, and its larger size. It differs from *Cl. Ehrenbergii* in its somewhat smaller size, and in the central row of pyrenoids present in each chloroplast.

24. **Closterium Ehrenbergii** Menegh.

(Pl. XVII, figs. 1–4.)

Closterium Ehrenbergii Menegh. Synops. Desm. 1840, p. 232; Hass. Brit. Freshw. Alg. 1845, p. 369, t. 87, f. 1; Ralfs, Brit. Desm. 1848, p. 166,

t. 28, f. 2; Arch. in Pritch. Infus. 1861, p. 748, t. 16, f. 10-14; Rabenh. Flor. Europ. Algar. III, 1868, p. 131; Kirchn. Alg. Schles. 1878, p. 141; Wolle, Desm. U.S. 1884, p. 45, t. 7, f. 16; Cooke, Brit. Desm. 1886, p. 23, t. 12, f. 2; Hansg. Prodr. Algenfl. Böhm. 1888, p. 182; De Toni, Syll. Alg. 1889, p. 844; Roy & Biss. Scott. Desm. 1894, p. 244; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 151; Alg. S. England, 1897, p. 481; G. S. West, Alga-fl. Cambr. 1899, p. 112; West & G. S. West, Alga-fl. Yorks. 1900, p. 51; Alg. N. Ireland, 1902, p. 23.

Arthrodia Ehrenbergii Kuntze, Revis. gen. plant. 1891, p. 883.

Cells large, stout, 4–5½ times longer than their diameter, moderately curved, outer margin 110°–120° of arc, inner margin concave but inflated in the median part, gradually attenuated to the apices, which are obtusely rounded; cell-wall smooth and colourless; chloroplasts with eight to ten ridges, and containing numerous scattered pyrenoids; terminal vacuole with a cluster of small moving granules.

Zygospore globose and smooth, with an outer mucous, lamellose coat.

Distance between apices (length) 382–541 μ; breadth 72–137 μ; breadth near apices 12–18 μ; diam. zygosp. 113–118 μ.

England.—Cumberland! Westmoreland (up to 2,400 ft. on Helvellyn)! (*Ralfs*). W., N., and E. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Essex! Cambridge! Gloucester (*Ralfs*). Middlesex! Surrey (zygosp. from Wimbledon Common)! (*Ralfs*). Sussex (*Ralfs*). Kent! (*Ralfs*). Hants! (*Roy*). Devon (*Bennett*). Cornwall! (*Ralfs*).

Wales.—Moel Fammau!, Glyder Fawr (at 2,700 ft.)!, Pen-y-gwryd (*Roy*), and Snowdon (at over 3,000 ft.), Carnarvonshire!

Scotland.—Ross, Inverness, Aberdeen!, Kincardine, Perth!, Fife (*Roy & Bissett*). Plankton of Loch Doon, Ayr! Sutherland! Orkneys! Shetlands!

Ireland.—Creggan Lough, Galway! Carrantuohill, Kerry! River Dargle, Wicklow! Dublin (*Archer*). Kilkeel, Down! Clough, Antrim!

Geogr. Distribution.—France. Belgium. Germany. Austria and Galicia. Bosnia in Hungary. Italy. Portugal. Norway. Sweden. Denmark. N., Central, and S. Russia. Faeroes. Central China. Japan. India. Siam. Samoa. New Zealand. Central Africa (var.). E. Africa. United States. W. Indies. Brazil. Uruguay. Patagonia.

The numerous scattered pyrenoids at once distinguish *Cl. Ehrenbergii* from all other allied species except *Cl. Malinvernianum*. It often occurs in abundance, and pure gatherings may sometimes be obtained from amongst other algæ in stagnant ponds and ditches, or even from slow-running streams.

The ventral inflation varies much in relative size and prominence, and the apices of some specimens are much thicker than those of others.

The form first mentioned by Borge (Süssw. Chlor. Archang. 1894, p. 16, t. 1, f. 11), and since found in Cambridgeshire (G. S. West, Alga-fl. Cambr. 1899, p. 112), is chiefly notable for its relative shortness and for the slight curvature of the ventral or inner margin (*vide* Pl. XVII, fig. 3). The curvature of the inner margin varies greatly in different specimens, and for this reason the form just mentioned is unworthy of a special varietal name.

Conjugation appears to take place almost invariably between two individuals which have just separated after division, and in which the younger semicells are but partially developed. Moreover, the semicells do not come apart, but a distinct, though very short, conjugating-tube is protruded from the base of each of the younger semicells.

25. **Closterium Malinvernianum** De Not.

(Pl. XVII, figs. 5, 6.)

Closterium Malinvernianum De Not. in Erb. crit. Ital. 1865, no. 1254 [we have not seen this]; Lund. Desm. Suec. 1871, p. 80; De Toni, Syll. Alg. 1889, p. 845; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 163; West & G. S. West, Alg. S. England, 1897, p. 481 (in part); Alga-fl. Yorks. 1900, p. 51; Alg. N. Ireland, 1902, p. 23.
Cl. Ehrenbergii Menegh. b. ? *Malinvernianum* Rabenh. Flor. Europ. Algar. III, 1868, p. 131.
Arthrodia Malinverniana Kuntze, Revis. gen. plant. 1891, p. 883.
Closterium Cordanum Gutw. Nonn. Alg. Nov. 1896, p. 40, t. 2, f. 19.

Cells large, 6–7 times longer than their diameter, moderately curved, outer margin 90°–110° of arc, median part of inner margin inflated, gently attenuated to the apices, which are obtusely rounded; cell-wall very finely striated, about 55–65 striæ visible across the cell, yellowish-brown in colour; chloroplasts with distinct ridges and scattered pyrenoids; terminal vacuoles with many moving granules.

Zygospore unknown.

Distance between apices (length) 294–400 μ; breadth 48–64 μ; breadth near apices 10–11 μ.

ENGLAND.—Adel Bog (*Turner*), Cam Fell, and Boston Spa, W. Yorks! Pilmoor, N. Yorks! Dernford Fen, Sheep's Green, and Wimpole Park, Cambridge! Esher West-end Common, and Frogit Heath, Surrey! Woolton Pond, Hants (*Roy*).

SCOTLAND.—Near Brin, Inverness; Bourtie, Aberdeen; Loch of Park, near Crathes, Kincardine; Athole Forest, near Loch Mharc, and E. of Falar, Perth (*Roy & Bissett*).

IRELAND.—Loughs Akibbon and Gartan, Donegal! Bog near lake at Toome, Antrim!

Geogr. Distribution.—Austria and Galicia. Italy. Spain. Norway. Sweden.

This species differs from *Cl. Ehrenbergii* only in its coloured and striated cell-wall, and in its somewhat smaller dimensions. Lundell states that it also differs from *Cl. Ehrenbergii* in its less prominent ventral inflation and in its less obtuse apices, but we find these features very variable in both species.

The striolation of the cell-wall is very delicate and apt to be at first sight overlooked.

26. **Closterium acerosum** (Schrank) Ehrenb.

(Pl. XVIII, figs. 2–5.)

Vibrio acerosus Schrank, 1803.
Bacillaria acerosa Schrank, 1823.
Closterium acerosum (Schrank) Ehrenb., 1828; Infus. 1838, p. 93, t. 2, f. xv, t. 6, f. i, t. 22, f. v; Menegh. Synops. Desm. 1840, p. 233; Hass. Brit. Freshw. Alg. 1845, p. 374, t. 87, f. 5; Ralfs, Brit. Desm. 1848, p. 164, t. 27, f. 2; De Bary, Conj. 1858, p. 51; Arch. in Pritch. Infus. 1861, p. 747; Rabenh. Flor. Europ. Algar. III, 1868, p. 128; Kirchn. Alg. Schles. 1878, p. 138; Wolle, Desm. U.S. 1884, p. 41, t. 6, f. 7, 11, t. 8, f. 17; Cooke, Brit. Desm. 1886, p. 20, t. 9, f. 1; Hansg. Prodr. Algenfl. Böhm. 1888, p. 179; De Toni, Syll. Alg. 1889, p. 824; Roy & Biss. Scott. Desm. 1894, p. 242; Nordst. Index Desm. 1896, p. 37; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 52; Freshw. Chlorophy. Koh Chang, 1901, p. 164, t. 2, f. 5; Alg. N. Ireland, 1902, p. 23.

Cl. acerosum A. *majus* Reinsch. Algenfl. Frank. 1867, p. 186.
Cl. acerosum a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 7, t. 1, f. 6.
Cl. acerosum var. *truncatum* Gutw. Wahr. d. Priorität, 1890, p. 66; Flor. Glon. Okolic Lwowa, 1891, p. 33, t. 1, f. 7; West & G. S. West, Alga-fl. Yorks. 1900, p. 52.
Arthrodia acerosa Kuntze, Revis. gen. plant. 1891, p. 883.

Cells large, 8–16 times longer than their diameter, very slightly bent or almost straight, narrowly fusiform, outer margin slightly curved (about 10°–20° of arc), inner margin almost straight or slightly convex; semicells gradually tapering to the apices, which are narrow and rounded-truncate (often slightly thickened); cell-wall colourless and smooth, in older individuals becoming yellowish-brown and very delicately striolate; chloroplasts ridged, with a median series of 7–11 pyrenoids; terminal vacuoles with a number of moving granules.

Zygospore globose and smooth.

Length 300–460 μ; breadth 26–48 μ; diam. zygosp. 62–87 μ.

ENGLAND.—Westmoreland! (*Ralfs*). W. (with zygosp.), N., and E. Yorks! Lancashire! (*Ralfs*). Cheshire (*Ralfs*). Leicester (*Roy*). Essex! Cambridge! Oxford! Warwick (*Wills*). Gloucester (*Ralfs*). Middlesex (with zygosp.)! Surrey! (*Ralfs*). Sussex (*Ralfs*). Kent! Hants! Devon! Cornwall! (*Ralfs*).

WALES.—General!

SCOTLAND.—Widely distributed, but scarce! (*Roy & Bissett*). Plankton of Loch Asta, Shetlands!

IRELAND.—Galway! Kerry! Dublin and Wicklow (*Archer*). Down! Antrim!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary and Bosnia (var.). Italy. Spain. Portugal. Norway. Sweden. Denmark. Bornholm. N. Russia. Iceland. Nova Zembla. Greenland. Siberia. Manchuria. Japan. India. Ceylon. Siam. Australia. New Zealand. United States. Mexico. Brazil. Ecuador. Patagonia.

Cl. acerosum is a common species and often occurs abundantly amongst larger filamentous Algæ. The cells frequently become somewhat irregular in outline owing to rapidity of cell-division. The striations on the cell-wall are exceedingly fine and delicate, and as a rule can only be observed on old individuals in which the cell-wall has become tinted.

The cells are often rather suddenly attenuated near their apices, and the extreme apex is commonly truncate and sometimes slightly thickened. This character, which is undoubtedly very variable, was first mentioned by Gutwinski, who gave the name of "var. *truncatum*" to those forms which possessed it.

Cl. acerosum is found most abundantly in low-lying districts, and for this reason there are large areas of Scotland in which it is very rarely observed.

Var. **elongatum** Bréb. (Pl. XVIII, fig. 1.)

Cl. acerosum β Ralfs, Brit. Desm. 1848, p. 164, t. 27, f. 2 *c*.
Cl. acerosum var. *elongatum* Bréb. Liste Desm. 1856, p. 152.
Cl. acerosum var. *acerosum* Cooke, Brit. Desm. 1886, p. 21.

Cells larger than in the typical form, relatively a little longer, and with the striolations of the cell-wall more distinct; cell-wall of a yellowish-brown colour.

Length 525–790 μ; breadth 29–50 μ.

ENGLAND.—Near Bristol, Gloucestershire (*Thwaites*). Sheep's Green, Cambridge!

Geogr. Distribution.—France. Germany. Ceylon. Mexico.

Var. **minus** Hantzsch.

Cl. acerosum var. *minus* Hantzsch. in Rabenh. Alg. Eur. 1861, no. 1047; Hansg. Prodr. Algenfl. Böhm. 1888, p. 179; De Toni, Syll. Alg. 1889, p. 825.
Cl. angustum Hantzsch. in Rabenh. Alg. 1861, no. 1206; Rabenh. Flor. Europ. Algar. III, 1868, p. 132; De Toni, Syll. Alg. 1889, p. 849.
Cl. acerosum B. *medium* Reinsch, Algenfl. Frank. 1867, p. 186.
Cl. acerosum E. *angustum* Reinsch, l.c. p. 187.
Arthrodia angusta Kuntze, Revis. gen. plant. 1891, p. 883.

A little smaller than the typical form, with a smooth and colourless cell-wall.

Length 176–336 μ; breadth 20–27 μ.

ENGLAND.—Leicester (*Roy*).

SCOTLAND.—Near Slains Castle, Bourtie, Little Don at Haughton, Aberdeen (*Roy & Bissett*). Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

Geogr. Distribution.—Austria. Ecuador.

Var. **angolense** West & G. S. West. (Pl. XVIII, fig. 6.)

Cl. acerosum var. *angolense* West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 79; G. S. West, Alga-fl. Cambr. 1899, p. 111.

Cells larger than in the typical form, with the lateral margins parallel, attenuated near each extremity to the apices, which are rounded; cell-wall smooth and colourless.

Length 773–780 μ; breadth 30–38 μ.

ENGLAND.—Near Ely, Cambridge!

Geogr. Distribution.—W. Africa.

27. **Closterium lanceolatum** Kütz.

(Pl. XVII, figs. 9, 10; Pl. XVIII, fig. 7.)

Closterium lanceolatum Kütz. Phycol. germ. 1845, p. 130; Ralfs, Brit. Desm. 1848, p. 164, t. 28, f. 1; Arch. in Pritch. Infus. 1861, p. 747; Rabenh. Flor. Europ. Algar. III, 1868, p. 129; Wolle, Desm. U.S. 1884, p. 39, t. 8, f. 14; Cooke, Brit. Desm. 1886, p. 21, t. 9, f. 2; De Toni, Syll. Alg. 1889, p. 826; Roy & Biss. Scott. Desm. 1884, p. 245; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 150; Nordst. Index Desm. 1896, p. 155; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1902, p. 52.

Cl. acerosum (Schrank) Ehrenb. D. ? *lanceolatum* Reinsch, Algenfl. Frank. 1867, p. 187.

Cl. acerosum b. *lanceolatum* Klebs, Desm. Ostpreuss, 1879, p. 7.

Arthrodia lanceolata Kuntze, Revis. gen. plant. 1891, p. 883.

Cells large, 5–10 times longer than their diameter, sublanceolate, almost straight, outer margin slightly curved, about 30°–36° of arc, inner margin straight or slightly convex, gradually narrowed towards the apices, which are acutely rounded; cell-wall smooth and colourless; chloroplasts with about eight ridges and a single central series of 6 or 7 pyrenoids; terminal vacuoles with a number of moving granules.

Zygospore subglobose or oblong-ellipsoid, smooth.

Length 234–370 μ; breadth 32–72 μ; diam. zygosp. 81–104 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W., N., and E. Yorks! Essex (zygosp. from Epping Forest)! Cambridge! Gloucester! Middlesex! Surrey! Kent!

WALES.—Capel Curig, and near Dolbadarn Castle, Carnarvonshire! Bodorgan, Anglesey!

SCOTLAND.—Near Falls of Kirkaig, Sutherland; near Haughton, Alford, and Koynach Moor in Cromar, Aberdeen (*Roy and Bissett*). Orkneys! Shetlands!

IRELAND.—Galway! Wicklow! Antrim (*Ralfs*). Down!

Geogr. Distribution.—France. Germany. Galicia in Austria. Hungary. Portugal. Norway. Sweden. Poland. Greenland. China. Madagascar. Central and E. Africa. United States. Patagonia.

The cells of *Cl. lanceolatum* are proportionately shorter than those of *Cl. acerosum*, the outer margin is more convex, and the extremities are more attenuated. The cell-wall is always colourless and striations have not been observed on it.

Var. **parvum** West & G. S. West. (Pl. XVII, fig. 11.)

Closterium lanceolatum var. *parvum* West & G. S. West, Alg. S. England, 1897, p. 481.

Cells about half the size of those of the typical form, but otherwise exactly similar.

Length 183 μ; breadth 21 μ.

ENGLAND. — Lindeth, Westmoreland! Dorking, Surrey!

Geogr. Distribution.—Central Africa.

28. **Closterium Lunula** (Müll.) Nitzsch.

(Pl. XVIII, figs. 8, 9.)

Vibris Lunula Müller, 1784.

Mülleria ? Lunula Leclerc, 1802.

Closterium Lunula (Müll.) Nitzsch, 1817; ? Kütz. Syn. Diat. 1834, p. 596, t. 18, f. 80; Menegh. Synops. Desm. 1840, p. 231; Ralfs, Brit. Desm. 1848, p. 163, t. 27, f. 1; Arch. in Pritch. Infus. 1861, p. 747; Reinsch. Algenfl. Frank. 1867, p. 186; Rabenh. Flor. Europ. Algar. III, 1868, p. 127; Delp. Desm. subalp. 1877, p. 95, t. 16, f. 1–3; Kirchn. Alg. Schles. 1878, p. 138; Wolle, Desm. U.S. 1884, p. 40, t. 50, f. 26 (figure bad); Cooke, Brit. Desm. 1886, p. 19, t. 8, f. 4; Hansg. Prodr. Algenfl. Böhm. 1888, p. 179; De Toni, Syll. Alg. 1889, p. 831; West, Alg. aq. dulc. Lusitan. 1892, p. 1498; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 160; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 52; Alg. N. Ireland, 1902, p. 23.

Cl. Lunula a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 6, t. 1, f. 1 *b*.

Arthrodia Lunula Kuntze, Revis. gen. plant. 1891, p. 883.

Cells large, stout, 6–7 times longer than their diameter, almost straight, outer margin 40°–45° of arc, inner margin generally straight and very slightly tumid in the median part, gradually and gently narrowed to the apices, which are slightly recurved and obtusely rounded; cell-wall smooth and colourless; chloroplasts with about ten to twelve ridges and numerous scattered pyrenoids; terminal vacuoles with a large cluster of moving granules.

Zygospore globose and smooth.

Length 478–680 μ; breadth 76–116 μ; breadth of apices about 19–23 μ.

England.—Cumberland! Westmoreland! W., N., and E. Yorks! Lancashire! Cheshire (*Ralfs*). Leicester (*Roy*). Norfolk (*Cooke*). Warwick (*Wills*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Kent! (*Ralfs*). Hants! (*Bennett*). Devon! Cornwall! (*Ralfs*).

Wales.—General!

Scotland.—General! (*Roy and Bissett*). General in Outer Hebrides! Orkneys!

Ireland. — Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Down!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Hungary. Italy. Portugal. Norway. Sweden. Denmark. Bornholm. N. and S. Russia. Caucasus. Faeroes. Iceland. Nova Zembla. Japan. India. Australia. New Zealand. W. and E. Africa. United States. Mexico. W. Indies. Brazil (var.). Ecuador. Paraguay. Uruguay. Patagonia.

This characteristic Desmid is not found in the situations in which *Cl. acerosum*, *Cl. lanceolatum*, and *Cl. Ehrenbergii* are often abundant. It has a decided preference for bogs and is commonly found in association with *Eremosphæra viridis*.

Forma **minor** *nob.*

Cl. Lunula forma, G. S. West, Alga-fl. Cambr. 1899, p. 111.

Smaller than the typical form, with a faintly straw-coloured cell-wall.

Length 375 μ; breadth 58 μ.
ENGLAND.—Sheep's Green, Cambridge!

Var. **coloratum** Klebs. (Pl. XVIII, fig. 10.)

Cl. Lunula b. *coloratum* Klebs, Desm. Ostpreuss. 1879, p. 6, t. 1, f. 1 *a*, *d*, *c*; De Toni, Syll. Alg. 1889, p. 832.
Cl. coloratum (Klebs) Gutw. Nonn. Alg. Nov. 1896, p. 38, t. 6, f. 16.

Cell-wall of a reddish-brown colour.
Length 633–646 μ; breadth 90–102 μ.
ENGLAND.—New Forest, Hants!
Geogr. Distribution.—Austria. Paraguay.

There is no just reason for regarding this form as a species distinct from *Cl. Lunula*. The *only* distinction is the colour of the cell-wall.

Var. **biconvexum** Schmidle. (Pl. XVIII, fig. 11.)

Cl. Lunula var. *biconvexum* Schmidle, Beitr. alp. Alg. 1895, p. 10 (sep.), t. 14, f. 18.

Cells about 5 times longer than their diameter, outer margin 50°–55° of arc, inner margin convex (about 30° of arc); cell-wall colourless.
Length 530–603 μ; breadth 110–126 μ.
ENGLAND.—Bowness, Westmoreland!
Geogr. Distribution.—Austrian Tyrol. Caucasus.

Var. **intermedium** Gutw. (Pl. XVIII, fig. 12.)

Cl. Lunula var. *intermedium* Gutw. Nonn. Alg. Nov. 1896, p. 39, t. 6, f. 17; West & G. S. West, Alga-fl. Yorks. 1900, p. 52.

Cells 5–6½ times longer than their diameter, outer margin more convex (about 70° of arc), inner margin prominently inflated in the median portion (sometimes entirely convex), apices somewhat suddenly attenuated and truncate.
Length 408–660 μ; breadth 71–140 μ.
ENGLAND.—Near Bowness, Westmoreland! Bog two miles S. of Clapham, W. Yorks!
Geogr. Distribution.—Galicia in Austria.

29. **Closterium sigmoideum** Lagerh. & Nordst.

(Pl. XIX, figs. 1, 2.)

Closterium sigmoideum Lagerh. & Nordst. in Wittr. & Nordst. Alg. Exsic. 1893, no. 1138; Nordst. Index Desm. 1896, p. 234; West & G. S. West, Alga-fl. Yorks. 1900, p. 53.

Cells large, 7–8 times longer than their diameter, almost straight in the front view, outer margin slightly curved (about 60° of arc), inner margin commonly straight, gradually attenuated to the apices, which are slightly recurved and obtusely rounded (rarely subtruncate); when seen from the side the cells are sigmoid; cell-wall colourless and smooth; chloroplasts with 8–12 pyrenoids in a somewhat irregular central series; terminal vacuoles with about twenty moving granules.

Zygospore unknown.

Length 270–330 μ; breadth 35–44 μ; breadth of apices 6–7 μ.

ENGLAND.—Eldwick, W. Yorks!

Geogr. Distribution.—Ecuador.

This is a well-marked species which we have only once obtained. It occurred in abundance in a boggy spring at Eldwick along with the forma *major*. From the side (or dorsal view) the cells possess a regular sigmoidal curvature similar to that found normally in *Pleurosigma*.

It is nearest to *Cl. Lunula* but is smaller and not so robust, and the apices although possessing the slight but characteristic recurvature of the latter species, are narrower. The chloroplasts also differ greatly from those of *Cl. Lunula*, possessing a central series of large pyrenoids.

Forma **major** West & G. S. West. (Pl. XIX, figs. 3–5.)

Cl. sigmoideum forma *major* West & G. S. West, Alga-fl. Yorks. 1900, p. 53.

Cells larger than in the typical form, but otherwise similar.

Length 482–552 μ; breadth 47–58 μ; breadth of apices 10–11 μ.

ENGLAND.—Eldwick, W. Yorks!

This occurred with the typical form, but was more abundant.

30. **Closterium Siliqua** West & G. S. West.

(Pl. XIX, figs. 6–8.)

Closterium Siliqua West & G. S. West, Alg. S. England, 1897, p. 480, t. 6, f. 1, 2.

Cells moderately large, about 10 times longer than their diameter, slightly curved, outer margin 30°–35° of arc, inner margin very slightly concave, margins almost parallel in the middle of the cell for about one-third its length, gradually attenuated towards the apices, which are narrow, subtruncate, and slightly recurved; cell-wall smooth and colourless; chloroplasts with about six ridges, and a single, somewhat irregular series of 7 or 8 pyrenoids; terminal vacuoles with only one large, oblong, moving granule.

Zygospore unknown.

Length 217–250 μ; breadth 21–24 μ; breadth of apices 4 μ.

ENGLAND.—Esher West-end Common, Surrey!

Cl. Siliqua is distinguished from *Cl. Pritchardianum* Arch. by its much smaller size, its much more tapering and narrower extremities, as well as by its smooth and colourless membrane. From *Cl. littorale* Gay, it differs in being a little longer, in the absence of the slight ventral inflation, and in the blunter and slightly recurved apices. It may also be compared with *Cl. subangulatum* Gutw. from which it differs in the subparallel median portion of the cells, in the absence of the ventral inflation, in the more convex outer margin, as well as in the recurved apices. From all the above, the living examples are distinguished by the terminal vacuoles possessing but one oblong moving granule.

31. **Closterium peracerosum** Gay.

(Pl. XIX, figs. 9–11.)

Closterium peracerosum Gay, Monogr. loc. Conj. 1884, p. 75, t. 2, f. 18; De Toni, Syll. Alg. 1889, p. 825; West & G. S. West, Alga-fl. Yorks. 1900, p. 53; Alg. N. Ireland, 1902, p. 23.

Arthrodia peracerosa Kuntze, Revis. gen. plant. 1891, p. 884.

Cells moderately large, about 12–14 times longer than their diameter, slightly curved, outer margin 30°–32° of arc, inner margin almost straight except towards the poles where it is slightly concave, gradually attenuated towards the apices, which are acute (or rarely acutely rounded); cell-wall smooth and colourless; chloroplasts with about six ridges and a central series of about four to six pyrenoids; terminal vacuoles with several small moving granules.

Zygospore unknown.

Length 180–303 μ; breadth 12–17·5 μ.

ENGLAND.—Rawcliffe Common, W. Yorks! Near Senens, Cornwall!

IRELAND.—Gortahork, Donegal!

Geogr. Distribution.—France. W. Africa.

This species should not, perhaps, be separated from *Cl. strigosum* Bréb. It is distinguished from Brébisson's species by its somewhat smaller size, its relative shortness, and its apices, which are not incurved.

Var. **elegans** G. S. West. (Pl. XIX, figs. 12, 13.)

Cl. peracerosum var. *elegans* G. S. West, Alga-fl. Cambr. 1899, p. 111, t. 396, f. 1, 2.

Cells more graceful, more attenuated and curved towards the apices, ventral margin slightly tumid in the middle, apices narrow but obtuse; chloroplasts with a series of 5–8 pyrenoids; apical vacuoles subterminal, with one or two moving granules.

Length 196–258 μ; breadth 14–15 μ.

ENGLAND.—Comberton and Sutton West Fen, Cambridge!

32. **Closterium littorale** Gay.

(Pl. XIX, fig. 14.)

Closterium littorale Gay, Monogr. loc. Conj. 1884, p. 75, t. 2, f. 17; De Toni, Syll. Alg. 1889, p. 848; West & G. S. West, Alg. S. England, 1897, p. 481; Alga-fl. Yorks. 1900, p. 53.
Arthrodia littoralis Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, about 10 times longer than their diameter, slightly curved, outer margin 35°–40° of arc, inner margin a little concave, and slightly but widely tumid in the middle, gradually attenuated to the apices, which are obtusely rounded; cell-wall smooth and colourless; chloroplast with eight ridges and a central series of 4 or 5 pyrenoids; terminal vacuoles with a number of moving granules.

Zygospore unknown.

Length 150–220 μ; breadth 17·5–22·5 μ.

England.—Masham, near Rievaulx Abbey, and Stokesley, N. Yorks! Kingsbury Green, Middlesex! Tremethick Moor, Cornwall!

Geogr. Distribution.—France. Galicia in Austria. Central Africa (var.).

33. **Closterium tumidum** Johnson.

(Pl. XIX, figs. 15–18.)

Closterium Cornu Ehrenb. var. β Ralfs, Brit. Desm. 1848, p. 176, t. 30, f. 6 *a–e*; Roy & Biss. Scott. Desm. 1894, p. 244.

Cl. Cornu b. forma *tumida* Rabenh. Flor. Europ. Algar. III, 1868, p. 137; De Toni, Syll. Alg. 1889, p. 836.

Cl. Cornu Wille, Ferskv. Alg. Nov. Semlj. 1879, p. 59, t. 14, f. 80, 81 (inclus. f. *major* Wille); Wille, Norges Ferskv. Alg. 1880, p. 57, t. 2, f. 38; West, Desm. Maine, 1888; Alg. N. Wales, 1890, p. 285.

Cl. tumidum Johnson, Rare Desm. U.S. II, 1895, p. 291, t. 239, f. 4; Nordst. Index Desm. 1896, p. 262; West & G. S. West, Some Desm. U.S. 1898, p. 284; Alga-fl. Yorks. 1900, p. 53; Chlorophy. Koh Chang, 1901, p. 166, t. 2, figs. 3, 4.

Cells rather small, 8–9 times longer than their diameter, slightly curved, outer margin 28°–58° of arc, inner margin broadly tumid in the middle, faintly concave towards the extremities, gradually attenuated towards the apices, which are truncately rounded and of somewhat variable width; cell-wall smooth and colourless; chloroplasts with four or six ridges, and 1–3 pyrenoids; terminal vacuoles with only one moving granule.

Zygospore subrectangular, with retuse sides; angles produced and truncately rounded; viewed from the side, elliptical.

Length 59–139 μ; breadth 7·7–18 μ; breadth of apices 2·5–5·5 μ; length of zygospore 34–37·5 μ; breadth of zygospore 20–30 μ.

ENGLAND.—Bowness, Westmoreland! Near Lindley Reservoir, Eldwick, and Ribblehead, W. Yorks!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Near Alford, Aberdeen (*Roy & Bissett*).

Geogr. Distribution.—Norway. Nova Zembla. Siam. Celebes. Samoa. United States. Brazil. Paraguay. Patagonia.

This species is distinguished from *Cl. Cornu* Ehrenb. by the shorter and broader cells, with a tumid ventral (or inner) margin.

34. **Closterium Cornu** Ehrenb.

(Pl. XX, figs. 1–5.)

Closterium Cornu **Ehrenb. 1830; Entwick. Lebends. d. Infus. 1832, p. 67; Infus. p. 94, t. 6, f. v; Menegh. Synops. Desm. 1840, p. 233; Hass. Brit. Freshw. Alg. 1845, p. 372, t. 88, f. 2; Ralfs, Brit. Desm. 1848, p. 176, t. 30, f. 6 *f*, *g*; Bréb. Liste Desm. 1856, p. 154; Arch. in Pritch. Infus. 1861, p. 750; Rabenh. Flor. Europ. Algar. III, 1868, p. 137; Kirchn. Alg. Schles. 1878, p. 140; Cooke, Brit. Desm. 1886, p. 35, t. 12, f. 4; Hansg. Prodr. Algenfl. Böhm. 1888, p. 181; De Toni, Syll. Alg. 1889, p. 835; West, Alg. aq. dulc. Lusitan. 1892, p. 1500; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 82; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 53; Alg. N. Ireland, 1902, p. 25, t. 2, f. 4, 5.**

Cl. tenue **Kütz. Syn. Diat. 1834, p. 595, t. 18, f. 78 (?).**

Stauroceras Cornu **Grun. Desm. u. Pediast. österreich. Moore, 1858, p. 497.**

Closterium pronum **Bréb. c *Cornu* Klebs, Desm. Ostpreuss. 1879, p. 19, t. 2, f. 13 *b*.**

Arthrodia Cornu **Kuntze, Revis. gen. plant. 1891, p. 883.**

Closterium Cornu **var. *siamense* West & G. S. West, Chlorophy. Koh Chang, 1901, p. 166, t. 2, figs. 6, 7.**

Cells small, 16–20 times longer than their diameter, slightly curved, outer margin 34°–40° of arc, inner margin slightly concave and usually straight in the median part, margins parallel until near the extremities, which are gradually attenuated; apices narrow, rounded or rounded-truncate; cell-wall smooth and colourless; chloroplasts with 3–5 pyrenoids; terminal vacuoles with one oblong moving granule.

Zygospore subquadrate or rectangular, sides straight, concave, or slightly convex, angles produced and submamillate.

Length 110–165 μ; breadth 6·5–8·8 μ; breadth of apices 1·6–3 μ; diameter of zygosp. 23–30 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W. and N. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Essex! Warwick (*Wills*). Middlesex! Surrey! Sussex (*Ralfs*). Kent! Hants! (*Roy*). Devon (*Bennett*). Cornwall! (*Marquand*).

WALES.—Near Dolbadarn Castle!, Llyn Cwlyd!, Capel Curig! (*Cooke & Wills*), and Pen-y-gwryd (*Roy*), Carnarvonshire. Holyhead, Anglesey! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—General! (*Roy & Bissett*). Shetlands!

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Antrim!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Portugal. Norway. Sweden. Denmark. N. and Central Russia. Poland. Færoes (form). Nova Zembla. Siam. Java. Samoa (var.). Australia (var.). Central Africa. United States. Brazil (var.).

This species has considerable resemblance to *Cl. gracile* Bréb., with some forms of which it may easily be confounded. It is, however, more regularly curved than *Cl. gracile* and the apices are more truncate. The zygospore is very different from that of *Cl. gracile*, and conjugated specimens could not be confused. It should also be compared with *Cl. tumidum*.

Ralfs' statement that the cells are "five to eight times longer than broad" is erroneous.

35. **Closterium abruptum** West.

(Pl. XX, figs. 6–10.)

Closterium abruptum West, Alg. Eng. Lake Distr. 1892, p. 719, t. 9, f. 1; Johns. Rare Desm. U.S. II, 1895, p. 291, t. 239, f. 5; West & G. S. West, Some N. Amer. Desm. 1896, p. 236, t. 13, f. 14, 15; Nordst. Index Desm. 1896, p. 36; West & G. S. West, Alg. S. England, 1897, p. 479; Alga-fl. Yorks. 1900, p. 54; Alg. N. Ireland, 1902, p. 22.

Cells small, about 10 times longer than their diameter, slightly curved, outer margin about 55° of arc, median portion of cells almost straight, more curved towards the extremities, gradually but slightly attenuated towards the apices, which are broad and truncate; cell-wall smooth, colourless or straw-coloured; chloroplasts with about six ridges and containing a central row of 4 or 5 pyrenoids; terminal vacuoles with one large moving granule.

Zygospore globose and smooth.

Length 127–156 μ; breadth 12–15·5 μ; breadth of apices 6–7 μ; diam. zygosp. 32–46 μ.

England.—Cumberland! Westmoreland! W. and N. Yorks! Lancashire! Surrey! Hants! Devon! Cornwall!

Wales.—Y Foel Fras, Capel Curig, Glyder Fach (at 2,000 ft.), Llyn-y-cwm-ffynon, and Llyn Gwynant, Carnarvonshire!

Scotland.—Loch Minnoch, Kirkcudbright! Loch Macaterick, Ayr! Near Lairg, Sutherland! Achnasheen, Ross! Moidart, Inverness! Near Tarbert, Harris and Balallan, Lewis, Outer Hebrides! Hoy, Orkneys! Plankton of Loch Beosseter, Shetlands!

Ireland.—Near Glenties, Loughs Anna and Clogher, and near Lough Magrath, Donegal! Oughterard, Galway! Shores of Lough Neagh!

Geogr. Distribution.—Germany (form). Austria and Galicia. Central Africa (form). United States. Brazil.

This is a well-marked species, some forms of which bear a slight resemblance to *Cl. tumidum* Johns., but these are at once distinguished by their stouter habit and broadly truncate apices.

In outward form *Cl. abruptum* resembles some of the small forms of *Cl. intermedium* Ralfs, but can at once be distinguished by its smooth cell-wall.

Forma **punctata** West.

Cl. abruptum forma *punctata* West, Alg. Eng. Lake Distr. 1892, p. 719.

A form with the cell-wall irregularly punctate. In other respects exactly similar to the type.

England.—Bog near Cockley Beck, Lancashire!

Var. **brevius** *nob.* (Pl. XX, figs. 11, 12.)

Cl. abruptum forma *brevior* West & G. S. West, New Brit. Freshw. Alg. 1894, p. 3, t. 1, f. 4.

Cells shorter and more curved, outer margin 80°–100° of arc.

Length 60–107 μ; breadth 15–16 μ.

WALES.—Ffestiniog, Merioneth!

Geogr. Distribution.—Austrian Tyrol.

Turner has described a "var. *cambricum*" of this species, which he says "differs from the type in being regularly curved, and in being proportionately shorter and thicker." His measurements are:—Length 114–130 μ; breadth 14–17 μ. The specimens were from Llyn Padarn, Carnarvonshire (*vide* Turn. Desm. Notes, 1893, p. 346). We think this variety must be the same as var. *brevius*, although Turner's specimens were a little larger.

36. **Closterium toxon** West.
(Pl. XX, figs. 13, 14.)

Closterium toxon West, Alg. W. Ireland, 1892, p. 121, t. 19, f. 14; Nordst. Index Desm. 1896, p. 255; West & G. S. West, Desm. Singapore, 1897, p. 158; Alga-fl. Yorks. 1900, p. 54; Alg. N. Ireland, 1902, p. 25.

Cells narrow and linear, elongate, 25–30 times longer than their diameter, straight for about two-thirds their length, with subparallel margins, outer margin slightly concave in the middle, towards the extremities gently incurved and gradually attenuated, apices subtruncate; cell-wall smooth and colourless; chloroplasts with a number of small scattered pyrenoids; terminal vacuoles with two or three moving granules.

Zygospore unknown.

Length 220–300 μ; breadth 8·5–10 μ; breadth of apices 5·5–8 μ.

ENGLAND.—Near Bowness, Westmoreland! Pilmoor, N. Yorks! Skipwith Common, E. Yorks!

SCOTLAND.—Sligachan in Skye, and Moidart, Inverness! Rhiconich and Loch Inver, Sutherland! Near Callernish and near Balallan, Lewis, Outer Hebrides! Plankton of Loch Nan Eun, N. Uist, Outer Hebrides!

IRELAND.—Loughs Anna and Sproule, Donegal!

Ballynahinch, and Derryclare Lough, Galway! Torc Mt. and Cromagloun, Kerry! Mourne Mts., Down!

Geogr. Distribution.—Singapore. United States.

This species is probably nearest to *Cl. gracile* Bréb., but is much stouter with broader apices, which are truncate. It sometimes occurs in immense quantity amongst the leaves of *Utricularia minor*, or in the jelly surrounding the filaments of *Batrachospermum vagum*.

37. **Closterium Balmacarense** Turner.

(Pl. XX, fig. 15.)

Closterium Balmacarense Turn. Desm. Notes, 1893, p. 347; Roy & Biss. Scott. Desm. 1894, p. 243, t. 4, f. 6; Nordst. Index Desm. 1896, p. 56.

Cells of medium size, about 16 times longer than their diameter, slightly and regularly curved, outer margin about 33° of arc (without apices), gradually attenuated, apices dilated and rounded-truncate; cell-wall smooth and colourless; chloroplasts with eight distinct ridges; pyrenoids--?

Zygospore unknown.

Length 315–322 μ; breadth 20–21 μ; breadth of apices 16 μ.

SCOTLAND.—Balmacarra, Ross (*A. W. Wills*).

Forma **minor** Turner. (Pl. XX, fig. 16.)

Cl. Balmacarense β minor Turn. Desm. Notes, 1893, p. 347; Roy & Biss. Scott. Desm. 1894, p. 244, t. 4, f. 7.

Smaller than the type; chloroplasts with six ridges.

Length 260 μ; breadth 16 μ; breadth of apices 12 μ.

SCOTLAND.—Balmacarra, Ross (*A. W. Wills*).

38. **Closterium Scoticum** Turner.

(Pl. XX, fig. 17.)

Closterium Scoticum Turn. Desm. Notes, 1893, p. 347; Roy & Biss. Scott. Desm. 1894, p. 248, t. 4, f. 8; Nordst. Index Desm. 1896, p. 230.

Cells of medium size, narrow and elongate, 26–36 times longer than their diameter, straight or but slightly curved, outer margin about 30° of arc, margins almost parallel for about seven-eighths of the length, slightly attenuated near the apices, which are capitate-truncate; cell-wall smooth, colourless, yellow, or reddish-brown; chloroplasts with a central row of pyrenoids.

Zygospore unknown.

Length 260–489 μ; breadth 10–13 μ; breadth of apices 8·5–12·5 μ.

SCOTLAND.—Balmacarra, Ross (*A. W. Wills*).

Var. **fusiforme** Turner. (Pl. XX, fig. 18.)

Cl. Scoticum var. *fusiforme* Turn. Desm. Notes, 1893, p. 347; Roy & Biss. Scott. Desm. 1894, p. 249, t. 4, f. 9.

Cells almost straight, decidedly fusiform.

Length 295–415 μ; breadth 12·5–15 μ; breadth of apices 9–11·5 μ.

SCOTLAND.—Balmacarra, Ross (*A. W. Wills*).

39. **Closterium pusillum** Hantzsch.

Closterium pusillum Hantzsch in Rabenh. Alg. Europ. 1861, no. 1008; Reinsch. Algenfl. Frank. 1867, p. 187; Rabenh. Flor. Europ. Algar. III, 1868, p. 125; De Toni, Syll. Alg. 1889, p. 820; Roy & Biss. Scott. Desm. 1894, p. 248; Nordst. Index Desm. 1896, p. 213.
Cl. pusillum a. *minor* Racib. Nonn. Desm. Polon. 1885, p. 63.
Arthrodia pusilla Kuntze, Revis. gen. plant. 1891, p. 884.

Cells very small, subcylindrical, 4–7½ times longer than their diameter, slightly curved, outer margin 40°–50° of arc, inner margin slightly concave, very gradually and gently attenuated to the apices, which are obtusely or truncately rounded; cell-wall smooth and colourless; chloroplasts with about six ridges and with one or two pyrenoids; terminal vacuoles prominent, with one or two moving granules.

Zygospore quadrate.

Length 30–50 μ; breadth 4–9 μ.

SCOTLAND.—Achnasheen, Ross; Auchterless, Long-side, Towie, near Alford, Birse, and Birsemore, Aberdeen; Loch of Park, Clunie, Cammie, Kincardine; Buchanty, Perth; near Tobermory in Mull, Argyll (*Roy & Bissett*).

Geogr. Distribution.—Germany. Austria and Galicia. Hungary. Sweden. Poland. W. Africa (var.). Brazil.

We have not seen the typical form of this species.

Var. **major** Racib. (Pl. XX, fig. 19.)

Cl. pusillum b. *major* Racib. Nonn. Desm. Polon. 1885, p. 63; De Toni, Syll. Alg. 1889, p. 820; West & G. S. West, Alga-fl. Yorks. 1900, p. 54.
Cl. pusillum β major Roy. & Biss. Scott. Desm. 1894, p. 248.

Larger than the typical form; terminal vacuoles with four or five moving granules.

Length 86–100 μ; breadth 13–16 μ.

ENGLAND.—Cocket Moss, near Giggleswick, W. Yorks! Mickle Fell, N. Yorks!

SCOTLAND.—Glen Callater, Corrie of Loch Kandor, Aberdeen; at the "Reeky Linn" on the Isla, Forfar (*Roy & Bissett*).

Geogr. Distribution.—Poland.

Var. **monolithum** Wittr. (Pl. XX, figs. 20–24.)

Cl. pusillum var. *monolithum* Wittr. in Wittr. & Nordst. Alg. Exsic. 1886, no. 836; De Toni, Syll. Alg. 1889, p. 820; Nordst. Index Desm. 1896, p. 213; West & G. S. West, Notes Alg. III, 1903, p. 9 (sep.).

Cells less curved, frequently with a faint median constriction; terminal vacuoles with only one moving granule.

Length 30–48 μ; breadth 9–10 μ.

ENGLAND. — Gurnard's Head, Cornwall, on damp ground!

Geogr. Distribution.—Austria.

40. **Closterium monotænium** Arch.

Closterium monotænium Arch. in Quart. Journ. Micr. Sci. 1876, p. 415 Cooke, Brit. Desm. 1886, p. 25; De Toni, Syll. Alg. 1889, p. 849; Nordst. Index Desm. 1896, p. 175.
Arthrodia monotænia Kuntze, Revis. gen. plant. 1891, p. 883.

Cells "small, comparatively stout, curvature slight, inflated in the middle, gradually tapering though still thick towards the apices, which are blunt and rounded; membrane smooth and colourless. Endochrome a single longitudinal band, not plicated, each locellus containing a single moving granule, forming a rounded cavity in the plasma, at some distance from the apex."

IRELAND.—Dublin and Wicklow (*Archer*).

The above is the only description ever published of this *Closterium*, and the size was not stated. We have not seen any Desmid in the genus which could be referred to it.

41. **Closterium prælongum** Bréb.

(Pl. XXI, figs. 1, 2.)

Closterium prælongum Bréb. Liste Desm. 1856, p. 152, t. 2, f. 41; Arch. in Pritch. Infus. 1861, p. 747; Rabenh. Flor. Europ. Algar. III, 1868, p. 130; Cooke, Brit. Desm. 1886, p. 22, t. 10, f. 2; Wolle, Freshw. Alg. U.S. 1887, p. 24, t. 55, f. 15, 16; De Toni, Syll. Alg. 1889, p. 830; Roy & Biss. Scott. Desm. 1894, p. 247; Nordst. Index Desm. 1896, p. 205; West & G. S. West, Alg. S. England, 1897, p. 480; Alga-fl. Yorks. 1900, p. 54.
Arthrodia prælonga Kuntze, Revis. gen. plant. 1891, p. 884.

Cells of medium size, very elongate, 30–45 times longer than their diameter, slightly curved, outer margin about 25°–30° of arc, inner margin slightly concave, not tumid, gradually attenuated towards the extremities which are a little recurved, apices obtuse or rounded-truncate; cell-wall smooth and colourless; chloroplasts with one series of 10 or 12 pyrenoids; terminal vacuoles with many moving granules.

Zygospore unknown.

Length 530–846 μ; breadth 11·5–24 μ.

ENGLAND.—Loughrigg, and near Bowness, Westmoreland! Malham Tarn Bog and Boston Spa, W. Yorks! Riccall Common, E. Yorks! Near Chapel Wood, S.E. Surrey!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Moss of Logie in Cromar, Aberdeen; Scolty Dam near Banchory, Kincardine (*Roy & Bissett*).

IRELAND. — Near Leenane, Galway! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Portugal. Poland. Bornholm. Siam. Central Africa (var.). United States. Brazil. Patagonia.

This is one of the rarest species of the genus, and one of the most elongate. It is characterised by the recurved apices and its smooth cell-wall.

Forma **brevior** West. (Pl. XXI, figs. 3–5.)

Cl. prælongum forma Nordst. Freshw. Alg. N. Zeal. 1888, p. 68, t. 3, f. 22–24.
Cl. prælongum forma *brevior* West, Add. Alg. W. Yorks. II, 1891, p. 244; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 151; Nordst. Index Desm. 1896, p. 205; West & G. S. West, Alg. S. England, 1897, p. 480; G. S. West, Alga-fl. Cambr. 1899, p. 111; West & G. S. West, Alga-fl. Yorks. 1900, p. 54; Alg. N. Ireland, 1902, p. 22.

Cells shorter, 14–22 times longer than the diameter. Zygospore globose and smooth.

Length 198–320 μ; breadth 12·5–17 μ; diam. zygosp. 40–46 μ.

ENGLAND.—W. and N. Yorks! Cambridge! Essex! Middlesex (zygosp. from Ruislip Reservoir)! Surrey!

SCOTLAND.—Bressay, Shetlands!

IRELAND.—Ram's Island and entrance of River Ballanderry, Lough Neagh!

Geogr. Distribution.—Portugal. Sweden. New Zealand.

This short form is more frequently met with than typical *Cl. prælongum*.

42. **Closterium strigosum** Bréb.

(Pl. XXI, figs. 6, 7.)

Closterium strigosum Bréb. Liste Desm. 1856, p. 153, t. 2, f. 43; Arch. in Pritch. Infus. 1861, p. 747; Rabenh. Flor. Europ. Algar. III, 1868, p. 130; Kirchn. Alg. Schles. 1878, p. 139; Wolle, Desm. U.S. 1884, p. 42, t. 6, f. 13, 14, t. 53, f. 9, 10; De Toni, Syll. Alg. 1889, p. 829; West, Alg. Eng. Lake Distr. 1892, p. 720; Roy & Biss. Scott. Desm. 1894, p. 249; Nordst. Index Desm. 1896, p. 241.
Cl. strigosum a. *typicum* Klebs, Desm. Ostpreuss, 1879, p. 8.
Arthrodia strigosa Kuntze, Revis. gen. plant. 1891, p. 884.

Cells of moderate size, 16–20 times longer than their diameter, slightly curved, median portion of cell straight, towards the extremities incurved, gradually attenuated to the apices, which are somewhat incurved and subacute; cell-wall smooth and colourless; chloroplasts with a central row of 7 or 8 pyrenoids; terminal vacuoles with several moving granules.

Zygospore ellipsoid and smooth.

Length 254–358 μ; breadth 14–18·5 μ.

England. — Scandale, Westmoreland! Rawcliffe Common, W. Yorks! Enbridge Lake, Hants (*Roy*).

Scotland.—Near Tain and Strathpeffer, Ross; Brin, Inverness; St. Fergus Canal, Mintlaw, Alford, Whitestripes, Danestone, and near Springhill, Aberdeen; Lochs of Park and Lumgair, Kincardine (*Roy & Bissett*). Glen Shee, Perth!

Ireland.—Dublin and Wicklow (*Archer*). Clough, Antrim!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Hungary. Sweden. Poland. N. Russia. Central and E. Africa. Brazil.

The nearest species to *Cl. strigosum* is *Cl. peracerosum* Gay, and it is indeed a doubtful question whether the latter species should not really be placed under the former. *Cl. peracerosum* is somewhat smaller in size, is relatively shorter, and has not the characteristic incurved apices of *Cl. strigosum*.

It seems very probable that various authors have confused these two species of *Closterium*. The measurements given by Lundell (Desm. Suec. 1871, p. 79) of *Cl. strigosum*, viz.—length 160–240 μ, breadth 10–16 μ, lead one to suppose that very possibly he had *Cl. peracerosum* under observation at the time. Similarly, the measurements given by Eichler (Mat. flor. Miedz. 1893, p. 58), viz.—length 145 μ, breadth 11 μ, are much smaller than the average for *Cl. strigosum*.

Wolle has described zygospores which he believed to be of this species, but as his figures are not good, and as he was somewhat doubtful with regard to the identification of his specimens, the observation requires confirmation.

43. **Closterium gracile** Bréb.

(Pl. XXI, figs. 8–12.)

Closterium gracile Bréb. in Cheval. Des microscop. et de leur usage, Paris, 1839, p. 272; Ralfs, Brit. Desm. 1848, p. 221; Bréb. Liste Desm. 1856, p. 155, t. 2, f. 45; Arch. in Pritch. Infus. 1861, p. 748; Kirchn. Alg.

Schles. 1878, p. 137; Wolle, Desm. U.S. 1884, p. 39, t. 6, f. 4, 5; Cooke, Brit. Desm. 1886, p. 22, t. 13, f. 8; Hansg. Prodr. Algenfl. Böhm. 1888, p. 178; De Toni, Syll. Alg. 1889, p. 818; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 132; West & G. S. West, New and Int. Freshw. Alg. 1896, p. 151, t. 4, f. 47; Alg. S. England, 1897, p. 54; Alga-fl. Yorks. 1900, p. 54; Alg. N. Ireland, 1902, p. 25; Freshw. Alg. Ceylon, 1902, p. 138.

Cl. juncidum Ralfs, forma *gracillima-lævissima* Rabenh. Flor. Europ. Algar. III, 1868, p. 127.

Cl. gracile forma *tenuissima* Heimerl, Desm. Alp. 1891, p. 591.

Arthrodia gracilis Kuntze, Revis. gen. plant. 1891, p. 883.

Closterium limneticum Lemm. Phytoplankton sächsis. Teiche, 1899, p. 28, t. 2, f. 39-41; *vide* West & G. S. West, Notes Alg. II, 1900, p. 290.

Cells small, slender and linear, 28–40 times longer than their diameter, almost straight for more than half their length, margins parallel, gradually narrowed and gracefully curved towards the apices, which are obtuse; cell-wall smooth and colourless; choroplasts sometimes subundulate, with 5 to 7 pyrenoids; terminal vacuoles with one to several moving granules.

Zygospore globose, angular-globose, or subquadrate with rounded angles, smooth.

Length 130–190 μ; breadth 3·4–6 μ; breadth of apices 1·2–2·4 μ; diam. zygosp. 20–25·7 μ.

ENGLAND.—Cumberland! Westmoreland! W., N., and E. Yorks! Lancashire! Cheshire (*Roy*). Essex! Cambridge! Oxford (zygosp. from near Goring)! Middlesex! Surrey! Hants. (zygosp. from New Forest)! Devon! Cornwall! (*Marquand*); zygosp. from Penzance (*Joshua*).

WALES.—Fairly general!

SCOTLAND.—Ross!, Sutherland!, Inverness!, Nairn, Aberdeen (with zygosp.), Kincardine, Forfar!, Perth!, Argyll (*Roy & Bissett*). General in Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Antrim! Down!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Portugal. Norway. Sweden. Denmark. N., Central, and S. Russia. Finland. Faeroes. Iceland. Siberia. Greenland. Ceylon. Siam. Sumatra. New Zealand. Australia. E. Africa. United States. Brazil. Paraguay. Patagonia.

Cl. gracile is a widely distributed species and is often abundant in collections from permanent bogs. It is undoubtedly nearest to *Cl. Cornu* Ehrenb., from which it is distinguished by its proportionately greater length, by the straighter median part of the cell, by the incurved and narrower apices, and by the form of the zygospore.

The curvature of *Cl. gracile* is very similar to that of *Cl. juncidum*, but in no other respect do these species resemble each other. They are in no way closely related.

The figures given by Brébisson and by Cooke are very poor representations of the species, and have led to considerable confusion.

The zygospores of this species are somewhat variable. They are seldom spherical, but are more often angular-globose or even subquadrate with rounded angles.

Var. **elongatum** *var. nov.* (Pl. XXI, figs. 14–16.)

Cells very elongate, 85–95 times longer than their diameter, apices obtusely rounded.

Length 276–360 μ; breadth 3–4 μ.

SCOTLAND.—Rhiconich, Sutherland!

IRELAND.—Cromagloun, Kerry! Clough, Antrim!

Var. **tenue** (Lemm.) West & G. S. West. (Pl. XXI, fig. 13.)

Cl. limneticum Lemm. var. *tenue* Lemm. Phytoplankton sächsis. Teiche, 1899, p. 28, t. 2, f. 42–44.

Cl. gracile var. *tenue* (Lemm.) West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 138, t. 18, f. 22, 23; Alg. N. Ireland, 1902, p. 25.

Cells smaller and somewhat thinner than in the typical form.

Length 69–110 μ; breadth 2·5–3·5 μ.

Scotland.—Near Tarbert, Harris, and Balallan, Lewis, Outer Hebrides! W. of Kirkwall, Orkneys!

Ireland.—Dungloe, Loughs Anna and Sproule, and near Lough Magrath, Donegal! Slieve Donard, Down!

Geogr. Distribution.—Germany. Ceylon.

This variety is sometimes very abundant amongst *Sphagnum cuspidatum*, intermingled with *Netrium Digitus* and *Staurastrum brachiatum*. We have previously commented upon the erroneous measurements given by Lemmermann.

44. **Closterium Lundellii** Lagerh.

(Pl. XXI, fig. 17.)

Closterium gracile Lund. Desm. Suec. 1871, p. 82, t. 5, f. 15.
Cl. Lundellii Lagerh. Bidr. Sverig. Algfl. 1883, p. 53; De Toni, Syll. Alg. 1889, p. 818; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 160.
Arthrodia Lundellii Kuntze, Revis. gen. plant. 1891, p. 883.

Vegetative cells exactly similar to those of *Cl. gracile* Bréb. Zygospore subquadrate with rounded angles, each angle furnished with a long spine which fits into the base of an empty semicell.

Length of zygospore without spines 28–30 μ, breadth 22 μ; length of spines 16–17·5 μ.

ENGLAND.—Enbridge Lake, Hants. (*Roy*).

WALES.—Bettws-y-coed, Carnarvonshire (*Roy*).

SCOTLAND.—Loch Inver, Sutherland; Fyvie, near Alford, and S.W. of Loch Kinnord, Aberdeen (*Roy*).

Geogr. Distribution.—Sweden.

Roy is the only observer who has recorded this Desmid as British, and he has never mentioned the occurrence of zygospores. As the vegetative cells are indistinguishable from those of *Cl. gracile,* these records must be regarded as doubtful. We give a copy of Lundell's figure of the zygospore (Pl. XXI, fig. 17).

45. **Closterium attenuatum** Ehrenb.

(Pl. XXII, figs. 1–3.)

Closterium attenuatum Ehrenb. Infus. 1838, p. 94, t. 6, f. iv; Menegh. Synops. Desm. 1840, p. 233; Ralfs, Brit. Desm. 1848, p. 169, t. 29, f. 5 (char. amend.); Arch. in Pritch. Infus. 1861, p. 749, t. 3, f. 43; Rabenh. Flor. Europ. Algar. III, 1868, p. 130; Kirchn. Alg. Schles. 1878, p. 138; Wolle, Desm. U.S. 1884, p. 41, t. 8, f. 5; Cooke, Brit. Desm. 1886, p. 32, t. 14, f. 1 (figure very bad); De Toni, Syll. Alg. 1889, p. 829; Lütkem. Desm. Attersees, 1893, p. 542; Roy & Biss. Scott. Desm. 1894, p. 243; Nordst. Index Desm. 1896, p. 54; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 55; Alg. N. Ireland, 1902, p. 24.
Cl. candianum Delp. Desm. subalp. 1877, p. 104, t. 17, f. 7–10. [*Cl. attenuatum* Ralfs, but not Ehrenb., according to Delponte.]
Arthrodia attenuata Kuntze, Revis. gen. plant. 1891, p. 883.
A. candiana Kuntze, l. c.

Cells large, 11–14 times longer than their diameter, slightly curved, outer margin about 45° of arc, inner margin not tumid, gradually attenuated towards each extremity, near the apices rather suddenly narrowed into an obtuse cone; cell-wall delicately striated, from 17–24 striæ visible across the cell, brown or reddish-brown in colour; chloroplasts obscurely ridged, with 6 or 7 pyrenoids in a central series; terminal vacuoles with a large number (about 20) of moving granules.

Zygospore unknown.

Length 432–528 μ; breadth 35–45 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). Lancashire! N. Yorks! Essex! Warwick (*Wills*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Kent (*Ralfs*). Hants! (*Roy*). Cornwall! (*Ralfs*).

WALES.—Capel Curig, Carnarvonshire! (*Cooke & Wills*).

SCOTLAND.—Widely distributed! (*Roy & Bissett*).

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Antrim!

Geogr. Distribution.—France. Germany. Austria and Galicia. Italy. Norway. Sweden. Denmark. Bornholm. N. Russia. Ceylon. United States. Brazil (var.).

The apices of this species are very incorrectly depicted by both Ralfs and Cooke, the apical attenuation being greatly exaggerated. There are also more striations on the cell-wall than are indicated by Ralfs.

The Desmid which Ralfs and all subsequent authors have referred to "*Cl. attenuatum*" appears to be somewhat different from the original *Cl. attenuatum* Ehrenb.; hence Delponte's name "*Cl. candianum.*" But since Ehrenberg's species has never been identified with anything else, it would only create confusion to upset the present unanimous interpretation accorded to the name *Cl. attenuatum.*

46. **Closterium turgidum** Ehrenb.

(Pl. XXII, figs. 4, 5.)

Closterium turgidum Ehrenb. Infus. 1838, p. 95, t. 6, f. vii; Menegh. Synops. Desm. 1840, p. 234; Hass. Brit. Freshw. Alg. 1845, p. 371, t. 87, f. 3; Ralfs, Brit. Desm. 1848, p. 165, t. 27, f. 3; Arch. in Pritch. Infus. 1861, p. 747, t. 3, f. 40; Rabenh. Flor. Europ. Algar. III, 1868, p. 129; Kirchn. Alg. Sches. 1878, p. 138; Wolle, Desm. U.S. 1884, p. 44, t. 6,

f. 15; Cooke, Brit. Desm. 1886, p. 21, t. 9, f. 3; Hansg. Prodr. Algenfl. Böhm. 1888, p. 180; De Toni, Syll. Alg. 1889, p. 827; West, Alg. Eng. Lake Distr. 1892, p. 720; Roy & Biss. Scott. Desm. 1894, p. 249; Nordst. Index Desm. 1896, p. 263; West & G. S. West, Alg. S. England, 1897, p. 480; Alga-fl. Yorks. 1900, p. 56; Alg. N. Ireland, 1902, p. 22.
Arthrodia turgida Kuntze, Revis. gen. plant. 1891, p. 884.

Cells large, moderately curved, 11–12 times longer than their diameter, outer margin about 50° of arc, inner margin not tumid, gradually attenuated towards the extremities, which are distinctly recurved, apices subtruncate; cell-wall finely striated, from 30–35 striæ visible across the cell, yellowish-brown or reddish-brown in colour; chloroplasts with about eight ridges and a central series of 7 or 8 pyrenoids; terminal vacuoles with many moving granules.

Zygospore unknown.

Length 650–791 μ; breadth 58–75 μ; breadth of apices 12–15 μ.

ENGLAND.—Cumberland! Westmoreland! Lancashire! N. Yorks! Cheshire (*Ralfs*). Essex! Surrey! (*Ralfs*). Sussex (*Ralfs*). Kent! (*Ralfs*). Hants! (*Ralfs*). Cornwall! (*Ralfs*).

WALES.—Capel Curig! (*Cooke & Wills*), Glyder Fawr (*Roy*), and Snowdon!, Carnarvonshire. Dolgelly, Merioneth! Lynn Coron, Anglesey!

SCOTLAND.—Sutherland!, Ross, Inverness!, Aberdeen, Kincardine, Forfar, Perth, Dumbarton, Argyll, Bute, Fife (*Roy & Bissett*).

IRELAND.—Near Glenties, Donegal! Loughs Aunierin and Creggan, Galway! Near Sugar-loaf Mt., Castletown, and Adrigole, Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Norway. Sweden. Bornholm. S. Russia. Poland. Siberia. Japan (var.). W. Africa. United States. W. Indies. Brazil. Ecuador. Paraguay.

This is one of the largest and most characteristic species of the genus. It is by no means common. *Cl. turgidum* Ehrenb. subsp. *giganteum* Nordst., a native of Brazil, is the largest known Desmid, reaching a length of over 1,300 μ.

47. **Closterium Pritchardianum** Arch.

(Pl. XXII, figs. 6–14.)

Closterium Pritchardianum Arch. Descript. new Cosm., etc. 1862, p. 250, t. 12, f. 25–27; Rabenh. Flor. Europ. Algar. III, 1868, p. 129; Cooke, Brit. Desm. 1886, p. 22, t. 10, f. 1, t. 15, f. 7; De Toni, Syll. Alg. 1889, p. 830; Roy & Biss. Scott. Desm. 1894, p. 247; Nordst. Index Desm. 1896, p. 206; West & G. S. West, Alg. S. England, 1897, p. 480; G. S. West, Alga-fl. Cambr. 1899, p. 111; West & G. S. West, Alga-fl. Yorks. 1900, p. 56; Alg. N. Ireland, 1902, p. 22.

Cl. pronum Bréb. forma *C. Pritchardianum* Reinsch, Algenfl. Frank. 1867, p. 188.

Arthrodia Pritchardianum Kuntze, Revis. gen. plant. 1891, p. 884.

Closterium turgidum Ehrenb. var. *decoratum* West, Alg. Eng. Lake Distr. 1892, p. 720.

Cells large, very slightly curved, 12–17 times longer than their diameter, outer margin about 24° of arc, inner margin straight or very slightly concave, not tumid, gradually attenuated towards the apices, which are slightly recurved, narrow, and truncate; cell-wall finely striated, 35–40 striæ visible across the cell, striæ composed of fine punctæ, of a yellowish colour, frequently becoming reddish-brown; chloroplasts with six to eight ridges, and a central series of 7 or 8 pyrenoids; terminal vacuoles with many moving granules.

Zygospore globose, subglobose, or ovoid, smooth.

Length 350–590 μ; breadth 30–46 μ; breadth of apices 7–8 μ; diam. zygosp. 83–108 μ.

ENGLAND.—Near Bowness, Westmoreland! Crimsworth Dean, W. Yorks! Market Weighton, E. Yorks! Sheep's Green, Cambridge! Sutton Park, Warwick (*Wills*). Mill-pond, E. of Chapel Wood, S.E. Surrey! Tremethick Moor, Cornwall (with zygosp.)!

SCOTLAND.—Ross, Aberdeen, Kincardine, Forfar, Perth, Stirling (*Roy & Bissett*). Inverness! Orkneys!

IRELAND.—Gweedore and Lough Akibbon, Donegal! Howth, Dublin (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Italy. Norway. Sweden. N. Russia. China. Brazil. Argentina.

The cell-wall of *Cl. Pritchardianum* is of a yellowish-brown or golden-brown colour, and is very finely striated. These striations are not infrequently subspiral in their arrangement, and when examined carefully they are seen to consist of a series of fine punctæ. Towards the apices the punctæ are often no longer arranged in lines, but become irregularly scattered.

The species is distinguished from *Cl. turgidum* by its somewhat smaller size, its relatively greater length and slighter curvature, and by its much narrower, truncate apices. The cell-wall is also rather more finely striated and the striæ consist of punctæ.

Lütkemüller has found specimens of this species with a length of 720 μ, and a Brazilian form (f. *maxima* Nordst.) reaches a length of 680 μ and a breadth of 65 μ.

Cl. Pritchardianum var. *minus* West (Alg. W. Ireland, 1892, p. 121, t. 19, f. 13) does not belong to *Cl. Pritchardianum*. We have only seen one specimen of it, and until we obtain further information with regard to it, it must be left in abeyance as a form to be inquired into.

48. **Closterium pronum** Bréb.

(Pl. XXIII, figs. 1–3.)

Closterium pronum **Bréb. Liste Desm. 1856, p. 157, t. 2, f. 42; Arch. in Pritch. Infus. 1861, p. 750; Rabenh. Flor. Europ. Algar. III, 1868, p. 136; Lund. Desm. Suec. 1871, p. 81; De Toni, Syll. Alg. 1889, p. 852; West, Alg. W. Ireland, 1892, p. 125; Roy & Biss. Scott. Desm. 1894, p. 247; Nordst. Index Desm. 1896, p. 206; West & G. S. West, Alg. S. England, 1897, p. 482; G. S. West, Alga-fl. Cambr. 1899, p. 113; West & G. S. West, Alga-fl. Yorks. 1900, p. 56; Alg. N. Ireland, 1902, p. 25; Scott. Freshw. Plankton, I, 1903, p. 525.**

Cl. Linea **Lund. Desm. Suec. 1871, p. 82.**

Cl. pronum a. typicum **Klebs, Desm. Ostpreuss. 1879, p. 19, t. 2, f. 12 a.**

Arthrodia prona **Kuntze, Revis. gen. plant. 1891, p. 884.**

Cells narrow and very elongated, 40–50 times longer than their diameter, straight or very slightly curved, outer margin not more than 10°–15° of arc, very gradually attenuated to the apices, which are long and pointed although the extreme end of the cell is rounded; cell-wall smooth and colourless [but, according to Brébisson, yellow-brown and finely striated]; chloroplasts obscurely ridged, with a row of 8 to 10 pyrenoids; terminal vacuoles some distance removed from the apices and occupying all the apical parts of the cell, containing from two to six moving granules.

Zygospore unknown.

Length 313–423 μ; breadth 5·7–9 μ.

England.—W., N., and E. Yorks! Cambridge! Essex! Surrey! Hants! (*Roy*). Cornwall! (*Marquand*).

Wales.—Glyder Fach (at 2,200ft.), Carnarvonshire!

Scotland.—Loch Hempriggs, Caithness; near Tain, Ross, Scotston Moor, Aberdeen (*Roy & Bissett*). Glen Shee, Perth! Rhiconich, Sutherland! Near Tarbert, Harris, Outer Hebrides!

Ireland.—Near Gweedore, River above Crolley Bridge, and Lough Anna, Donegal! Near Westport, Mayo! Near Leenane, Oughterard, Clifden, and Ballynahinch, Galway! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Sweden. Denmark. N. Russia. Greenland. Japan. Java (form). Australia. Central and E. Africa. United States. Guiana. Patagonia.

The *Closterium pronum* of recent authors does not strictly agree with the *Closterium* described by Brébisson under that name. Brébisson described the cell-wall as being yellowish or pale-brown and very delicately striated, but these striations have not since been detected. We have never yet seen a specimen in which there was the slightest trace of striation or even colouration of the cell-wall. The breadth given by Brébisson (12–16 μ) is also much greater than the breadth of any specimen we have seen.

It is not an uncommon species in large bodies of water, such as at the margins of lakes, etc., and it is also a constituent of the fresh-water plankton.

The terminal vacuoles are very long, and the moving granules can wander along for some distance.

49. **Closterium aciculare** Tuffen West.

(Pl. XXVI, figs. 18, 19.)

Closterium aciculare Tuffen West, Rem. Diat. Desm. 1860, p. 153, t. 7, f. 16; Arch. in Quart. Journ. Micr. Sci. 1866, p. 181; Cooke, Brit. Desm. 1886, p. 36, t. 15, f. 1; De Toni, Syll. Alg. 1889, p. 837; Roy & Biss. Scott. Desm. 1894, p. 243; Nordst. Index Desm. 1896, p. 38.

Arthrodia acicularis Kuntze, Revis. gen. plant. 1891, p. 883.

Cl. gracile Bréb. forma *gracillima* West, Alg. W. Ireland, 1892, p. 122 t. 19, f. 15.

Cells very narrow and greatly elongated, 85–95 times longer than their diameter, almost straight for above half their length, very gradually and almost imperceptibly attenuated from the middle to the apices, which are slightly incurved, acute or acutely rounded, and very narrow; cell-wall smooth and colourless; chloroplasts with from 6 to 8 pyrenoids; terminal vacuoles very long and containing one (or two) moving granules.

Zygospore unknown.

Length 440–590 μ; breadth 5–7 μ.

England.—Northumberland (*Tuffen West*). Yorkshire (*Cooke*). Crosby Warren, Lincolnshire! (*Fowler*). Leicester (*Roy*). Devon (*Bennett*).

Scotland.—Near Tain, Ross; Dinnet Moss, Aberdeen (*Roy & Bissett*). Kirkwall, Orkneys!

Ireland.—Arderry Lough, Galway! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Italy. Faeroes.

Var. **subpronum** *nob.* (Pl. XXIII, figs. 4, 5.)

Closterium subpronum West, New Brit. Freshw. Alg. 1894, p. 3, t. 1, f. 3; G. S. West, Alga-fl. Cambr. 1899, p. 113; West & G. S. West, Alga-fl. Yorks. 1900, p. 56; Alg. N. Ireland, 1902, p. 25, t. 2, f. 1, 2.

Cells commonly more elongate than in the type, straight, very slightly curved, or sigmoid, 85–144 times longer than their diameter, median portion of the cell with subparallel margins, then gradually attenuated to the apices, which are very narrow, much drawn out with parallel margins, and obtuse at the extremity; chloroplasts only extending half way from the middle to the extremity of the cell; one moving granule in the terminal vacuole.

Length 392–716 μ; breadth 3·7–5·2 μ; breadth of apices 1·6 μ.

England.—Malham Tarn, W. Yorks! Pilmoor, N. Yorks! Sandholme, E. Yorks! Wicken Fen, Cambridge!

SCOTLAND.—Plankton of Loch Fadaghoda, Lewis, Outer Hebrides! Plankton of Loch Asta, Shetlands!

IRELAND.—Plankton of Lough Neagh!

Geogr. Distribution. — Germany. New Zealand (form).

This variety is sometimes frequent in the freshwater plankton and is the longest known Desmid in proportion to its breadth.

Börgesen & Ostenfeld (Phytoplankton Færöes, 1903, p. 620) state that *Cl. subpronum* must be placed as a synonym of *Cl. aciculare*. The *Closteria* recorded by these authors from the Faeroes are most probably forms of *Cl. aciculare*, but we doubt if either of them have observed any examples of *Cl. subpronum*. We have ourselves here placed *Cl. subpronum* as a variety of *Cl. aciculare* as we think its characters do not warrant its complete separation.

The var. *subpronum* differs from typical *Cl. aciculare* in two important points,—(1) the median portion of the cell is cylindrical, and (2) the apices are much more produced, being of a uniform thickness with parallel margins, and obtuse, although very narrow at the extremity. The extremities of the cell are produced into long colourless processes such as those found in *Cl. setaceum*; and the apical vacuoles, although containing only one moving granule, are of great length and contained within the base of these processes.

"*Cl. subpronum* var. *lacustre*" Lemm. (Planktonalgen, 1899, p. 344, t. 1, f. 13, 14) should be relegated to this variety, although the dimensions are a little larger,—length 500–800 μ; breadth 6–8 μ.

50. **Closterium Ceratium** Perty.

(Pl. XXIII, figs. 6–8.)

Closterium Ceratium Perty, Kleinst. Lebensf. 1852, p. 206, t. 16, f. 21; Rabenh. Flor. Europ. Algar. III, 1868, p. 138; De Toni, Syll. Alg. 1889, p. 837; Lütkem. Desm. Attersees, 1893, p. 543; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 72; West & G. S. West, Alga-fl. Yorks. 1900, p. 56; Alg. N. Ireland, 1902, p. 25.
Arthrodia Ceratium Kuntze, Revis. gen. plant. 1891, p. 883.

Cells small, 20–40 times longer than their diameter, straight, slightly curved, or sigmoid, gradually attenuated from the middle to the extremities, apices drawn out into very acute, needle-like points; cell-wall smooth and colourless; chloroplasts with four or five pyrenoids; terminal vacuoles remote from the apex, with one moving granule.

Zygospore globose and smooth.

Length 110–260 μ; breadth 6–6·5 μ.

ENGLAND.—Helvellyn, Westmoreland! Mickle Fell, N. Yorks! Delamere, Cheshire (*Roy*). Wimbledon and Esher Commons, Surrey! Enbridge Lake, Hants (*Roy*).

SCOTLAND.—General but scarce; zygospores from Scotston Moor and Slewdrum, Aberdeen (*Roy & Bissett*).

IRELAND.—Plankton of Lough Neagh!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Sweden.

We always find the apices of this species to be drawn out into fine, almost bristle-like points. They are, in fact, the sharpest apices met with in the whole of the genus. Rabenhorst also describes the apices as "acutissimis, hyalinis," but continental observers have recorded under the name "*Cl. Ceratium*," specimens with relatively obtuse extremities.

It is nearest to *Cl. pronum* Bréb., from which it is distinguished by its relative shortness, by the variable curvature of the cell, and by the much sharper and more produced apices.

51. **Closterium acutum** (Lyngb.) Bréb.

(Pl. XXIII, figs. 9–14.)

Echinella acuta Lyngbye, 1819.

Frustulia acuta Kütz. Syn. Diat. 1834, p. 537.

Closterium tenerrimum Kütz. Phyc. germ. 1845, p. 130.

Closterium acutum Bréb. in Ralfs' Brit. Desm. 1848, p. 177, t. 30, f. 5, t. 34, f. 5 *a*, *b*, *d-f*; De Bary, Conj. 1858, p. 41, t. 5, f. 13; Rabenh. Flor. Europ. Algar. III, 1868, p. 137; Kirchn. Alg. Schles. 1878, p. 140; Wolle, Desm. U.S. 1884, p. 44, t. 7, f. 11, 12; Cooke, Brit. Desm. 1886, p. 35, t. 14, f. 5; De Toni, Syll. Alg. 1889, p. 836; West, Alg. W. Ireland, 1892, p. 125; Alg. Eng. Lake Distr. 1892, p. 720; Roy & Biss. Scott. Desm. 1894, p. 243; Nordst. Index Desm. 1896, p. 39; West & G. S. West, Alg. S. England, 1897, p. 482; G. S. West, Alga-fl. Cambr. 1899, p. 113; West & G. S. West, Alga-fl. Yorks. 1900, p. 56; Alg. N. Ireland 1902, p. 25.

Stauroceras acuta Grun. Desm. u. Pediast. österreich. Moore, 1858, p. 497.

Closterium pronum Bréb. b. *acutum* Klebs, Desm. Ostpreuss. 1879, p. 19, t. 2, f. 12 *b*, 13 *c*.

Arthrodia acuta Kuntze, Revis. gen. plant. 1891, p. 883.

Cells small, 20–33 (rarely 15) times longer than their diameter, moderately and regularly curved, outer margin 45°–60° of arc, inner margin not tumid, gradually attenuated to the apices, which are acute; cell-wall smooth and colourless; chloroplasts with four or five small pyrenoids in a central series; terminal vacuoles with several small moving granules.

Zygospore oblong-rectangular, sides concave or slightly convex, ends concave, angles produced into mamillate or conical projections; from the side view the zygospore is elliptical.

Length 132–146 μ; breadth 3·8–6 μ; length of zygospore 23–49 μ; breadth of zygospore 12–27 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W. (with zygosp.), N., and E. Yorks! Lancashire! (*Ralfs*). Essex! Oxford (with zygosp.)! Cambridge! Warwick (*Wills*). Middlesex! Surrey! Sussex (*Ralfs*). Hants! (*Bennett*). Cornwall! (*Ralfs*).

WALES.—General!

SCOTLAND.—Common!; zygosp. from Aberdeen and Kincardine (*Roy & Bissett*). Harris and Lewis, Outer Hebrides! Shetlands!

IRELAND.—General! Also in plankton of Lough Neagh!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Hungary. Norway. Sweden. Denmark. N. and S. Russia. Faeroes. Nova Zembla. Spitzbergen. Greenland. Central China. India. Siam. Sumatra. Java. Australia. New Zealand. E. Africa. United States.

This is one of the most abundant of the small species of *Closterium*, and with the exception of *Cl. parvulum* is the one most often met with in the conjugated state.

Var. **Linea** (Perty) West & G. S. West. (Pl. XXIII, fig. 15.)

Closterium Linea Perty, Kleinst. Lebensf. 1852, p. 206, t. 16, f. 20; Arch. in Quart. Journ. Micr. Sci. 1866, p. 71; Rabenh. Flor. Europ. Algar. III, 1868, p. 139; De Toni, Syll. Alg. 1889, p. 854; West, Alg. W. Ireland, 1892, p. 125; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 158; West & G. S. West, Alg. S. England, 1897, p. 482.

Cl. pronum Bréb. d. *Linea* Klebs, Desm. Ostpreuss. 1879, p. 19, t. 2, f. 14 *b*.
Arthrodia Linea Kuntze, Revis. gen. plant. 1891, p. 883.
Closterium acutum (Lyngb.) Bréb. var. *Linea* (Perty) West & G. S. West, Alga-fl. Yorks. 1900, p. 57; Alg. N. Ireland, 1902, p. 25.

Cells straight or almost straight, sometimes a little curved at the apices which are acute; chloroplasts with two to four small pyrenoids; terminal vacuoles frequently occupying one-third the length of the cell and containing from one to eight small moving granules.

Zygospore similar to that of the type.

Length 134–163 μ; breadth 3·8–5 μ; length of zygospore 31–41·5 μ; breadth of zygosp. 13–16 μ.

ENGLAND.—Westmoreland! W. and N. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Essex! Surrey! Kent! Hants (*Bennett*). Cornwall! (*Marquand*).

WALES.—Bog above Capel Curig lakes, and Glyder Fach, Carnarvonshire!

SCOTLAND.—General, with zygosp. (*Roy & Bissett*). General in Outer Hebrides!

IRELAND.—More or less general!

Geogr. Distribution.—France. Germany. Switzerland. Austria and Galicia. Norway. Sweden. Japan. Guiana.

Cl. Linea must be regarded as merely a variety of *Cl. acutum* as it only differs from that species in its somewhat straighter cells. The zygospores of the two are exactly similar.

Lütkemüller gives "length 72–110 μ; breadth 3 μ" for *Cl. Linea*, but we have never observed any British specimens so small as this.

52. **Closterium subulatum** (Kütz.) Bréb.

(Pl. XXIII, figs. 16–19.)

Frustulia subulata Kütz. Syn. Diat. 1834, p. 538, t. 13, f. 1.
Closterium subulatum (Kütz.) Bréb. in Cheval. Des microscop. et leur usage, Paris, 1839, p. 272; Cooke, Brit. Desm. 1886, p. 36, t. 15, f. 4; West, Alg. W. Ireland, 1892, p. 125; Roy & Biss. Scott. Desm. 1894, p. 249; Nordst. Index Desm. 1896, p. 248; West & G. S. West, Alga-fl. Yorks. 1900, p. 57.
? *Stauroceras subulata* Kütz. Phyc. germ. 1845, p. 133.
Closterium acutum (Lyngb.) Bréb. var. β Ralfs, Brit. Desm. 1848, p. 177, t. 30, f. 5 *c*.

Cells small, moderately curved, 17–20 times longer than their diameter, outer margin 28°–45° of arc, inner margin slightly tumid, gradually attenuated from the middle towards the apices, which are acutely rounded; cell-wall smooth and colourless; chloroplasts with three or four pyrenoids; terminal vacuoles with several moving granules.

Zygospore subglobose or ovoid-globose, smooth.

Length 102–180 μ; breadth 6–12·5 μ; diam. zygosp. 19–23 μ.

ENGLAND.—Rombald's Moor, Cockett Moss, and Cam Fell, W. Yorks! Great Shunnor Fell, Lund's Fell, and Craydale Moor (1,900 ft.), N. Yorks!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Brin, Inverness; Aboyne, Aberdeen; Glen Coe, Argyll (*Roy & Bissett*).

IRELAND.—Lough Aunierin, and near Oughterard, Galway! Adrigole, Kerry!

Geogr. Distribution.—Austria. Norway. Sweden. United States.

This small species differs principally from *Cl. acutum* in the slightly tumid inner margins of the cells, in the more rounded apices, and in the subglobose zygospore.

53. **Closterium idiosporum** West & G. S. West.

(Pl. XXIII, figs. 20, 21.)

Closterium idiosporum West & G. S. West, Notes Alg. II, 1900, p. 290, t. 412, f. 6, 7.

Cells small, slightly curved, 20–23 times longer than their diameter, outer margin about 25° of arc, inner margin very slightly tumid, median portion of cell with subparallel margins, gradually attenuated to the apices, which are very narrow but truncate; cell-wall smooth and colourless; chloroplasts with four or five pyrenoids in a median series.

Zygospore narrowly ellipsoid, seen from the end circular; wall somewhat thick and densely scrobiculate.

Length 221–238μ; breadth 10–10·5μ; breadth of apices 1·7μ; length of zygosp. 57·5μ; breadth of zygosp. 28·7μ.

ENGLAND.—Wicken Fen, Cambridge!

This species is proportionately shorter than *Cl. pronum* Bréb., the apices being much less produced and truncate. It is somewhat larger than *Cl. acutum* (Lyngb.) Bréb., and its apices are quite different. The zygospore is also peculiar.

54. **Closterium lineatum** Ehrenb.

(Pl. XXIV, figs. 1–5.)

Closterium lineatum Ehrenb. 1834; Infus. 1838, p. 96, t. 6, f. viii; Menegh. Synops. Desm. 1840, p. 234; Hass. Brit. Freshw. Alg. 1845, p. 372, t. 88, f. 1; Ralfs, Brit. Desm. 1848, p. 173, t. 30, f. 1; Arch. in Pritch. Infus. 1861, p. 749, t. 3, f. 41, 42; Rabenh. Flor. Europ. Algar. III, 1868, p. 130; Lund. Desm. Suec. 1871, p. 79; Delp Desm. Subalp. 1877, p. 117, t. 17, f. 28–30; Kirchn. Alg. Schles. 1878, p. 139; Wolle, Desm. U.S. 1884, p. 43, t. 6, f. 16; Cooke, Brit. Desm. 1886, p. 31, t. 12, f. 1, t. 15, f. 5; Hansg. Prodr. Algenfl. Böhm. 1888, p. 180; De Toni, Syll. Alg. 1889, p. 838; West, Alg. W. Ireland, 1892, p. 124; Lütkem. Desm. Attersees, 1893, p. 543; Roy & Biss. Scott. Desm. 1894, p. 246; Nordst. Index Desm. 1896, p. 158; West & G. S. West, Alg. S. England, 1897, p. 482; G. S. West, Alga-fl. Cambr. 1899, p. 113; West & G. S. West, Alga-fl. Yorks. 1900, p. 55; Alg. N. Ireland, 1902, p. 24; Scott. Freshw. Plankton, I, 1903, p. 525.

Arthrodia lineata Kuntze, Revis. gen. plant. 1891, p. 883.

Closterium didymocarpum Schmidle, Alg. aus Nyassa-See, 1903, p. 65, t. 1, f. 15, 21.

Cells large, long and narrow, 16–24 times longer than their diameter, moderately curved, median portion of the cell fairly straight and cylindrical, inner margin faintly and widely tumid, moderately curved and gradually attenuated towards the apices, which are broad and truncately rounded; cell-wall striated, striæ rather variable, from 10 to 20 visible across the cell, yellow-brown or reddish-brown in colour; chloroplasts with about six ridges and a median row of nine to eleven pyrenoids; terminal vacuole with a close cluster of several moving granules.

Zygospore double; each part ovoid or ovoid-ellipsoid, with thick, smooth walls.

Length 415–760μ; breadth 17–35μ; breadth of apices 7–10μ; diam. of zygosp. 44–68·5μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). Lancashire! (*Ralfs*). W., N., and E. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Essex! Cambridge! Warwick (*Wills*). Surrey! Kent! Sussex (*Ralfs*); with zygosp. (*Jenner*). Hants! (*Roy*). Devon! Cornwall! (*Ralfs*); with zygosp. (*Joshua*).

WALES.—Carnarvon (*Ralfs*), Capel Curig! (*Cooke & Wills*), and Snowdon!, Carnarvonshire. Dolgelly, Merioneth! (*Ralfs*).

SCOTLAND.—Sutherland!, Ross, Inverness, Aberdeen!, Kincardine, Forfar, Perth! (*Roy & Bissett*). Harris, Outer Hebrides!

IRELAND.—Donegal (with zygosp.)! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Down! Antrim!

Geogr. Distribution.—France. Belgium. Germany. Austria and Galicia. Hungary. Italy. Norway. Sweden. Denmark. Bornholm. N. and S. Russia. Faeroes. Japan. India. Ceylon. Sumatra. Australia. New Zealand. Central and E. Africa. United States. Mexico. Brazil. Ecuador.

This species is characterised by its relative length, its incurved extremities, its striated membrane, and its peculiar double zygospore. The number of striæ varies considerably, almost more than in any other species of striated *Closterium*, but in all cases they are strong and well marked.

Forma **spirostriolata** *nob.*

Cl. lineatum var. β Ralfs, Brit. Desm. 1848, p. 173.

Cl. lineatum b. Forma *striis longitudinalibus spiralibus* Rabenh. Flor. Europ. Algar. III, 1868, p. 130; Roy & Biss. Scott. Desm. 1894, p. 246.

Striæ spirally disposed; otherwise similar to the type.

SCOTLAND.—Near Loch Dawan, Aberdeen (*Roy & Bissett*).

55. **Closterium Ralfsii** Bréb.

(Pl. XXIV, figs. 6, 7.)

Closterium Ralfsii Bréb. in Jenner's Flor. Tunbridge Wells, 1845, p. x; Bréb. in Ralfs' Brit. Desm. 1848, p. 174, t. 30, f. 2; Arch. in Pritch.

Infus. 1861, p. 749; Rabenh. Flor. Europ. Algar. III, 1868, p. 135; Wolle, Desm. U.S. 1884, p. 46, t. 7, f. 10; Cooke, Brit. Desm. 1886, p. 32, t. 14, f. 2, t. 15, f. 8; Hansg. Prodr. Algenfl. Böhm. 1888, p. 183; De Toni, Syll. Alg. 1889, p. 847; Roy & Biss. Scott. Desm. 1894, p. 248; Nordst. Index Desm. 1896, p. 220; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. York. 1900, p. 57.

? *Cl. Ralfsii* b. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 18, t. 2, f. 6 *b*, *c*.

Arthrodia Ralfsii Kuntze, Revis. gen. plant. 1891, p. 884.

Cells large, 6–8 times longer than their diameter, moderately curved, outer margin about 35° of arc, inner margin much inflated for over half the length of the cell, somewhat suddenly attenuated towards the extremities, which are drawn out, somewhat narrow, and slightly incurved; apices obtuse; cell-wall finely striated, 28–33 striæ visible across the cell, yellow-brown or reddish-brown in colour; chloroplasts obscurely ridged, with a median series of about five pyrenoids; terminal vacuole with four or five large moving granules clustered together to form a single mass.

Zygospore unknown.

Length 315–454 μ; breadth 42–50 μ; breadth of apices 9–10 μ.

England. — Westmoreland! (*Ralfs*). Lancashire (*Ralfs*). W. Yorks! Norfolk (*Cooke*). Sussex (*Ralfs*). Kent! (*Ralfs*). Cornwall (*Marquand*).

Wales. — Carnarvon (*Ralfs*) and Capel Curig! (*Cooke & Wills*), Carnarvonshire. Dolgelly, Merioneth (*Ralfs*).

Scotland. — Ross, Aberdeen, Kincardine, Forfar, Argyll (*Roy & Bissett*). Rhiconich, Sutherland!

Geogr. Distribution.—France. Germany. Austria and Galicia. Norway. Sweden. Bornholm. Iceland. Greenland. Siberia. Australia. Central Africa. United States. Brazil.

The type of *Cl. Ralfsii* is one of the rarest and most striking of British *Closteria*. We have seen very few specimens of it.

Var. **hybridum** Rabenh. (Pl. XXIV, figs. 8–13.)

Closterium Ralfsii var. *hybridum* Rabenh. Krypt. Fl. Sachs. 1863, p. 174; Flor. Europ. Algar. III, 1868, p. 135; De Toni, Syll. Alg. 1889, p. 848;

West, Alg. W. Ireland, 1892, p. 124; Alg. Eng. Lake Distr. 1892, p. 720; West & G. S. West, Desm. Singapore, 1897, p. 159 (inclus. forma *major*); Alg. S. England, 1897, p. 482; Some Desm. U.S. 1898, p. 284; Chlorophy. Koh Chang, 1901, p. 166; Freshw. Alg. Ceylon, 1902, p. 138.

Cl. lineatum Ehrenb. var. *sandvicense* Nordst. Alg. aq. dulc. et Char. Sandvic. 1878, p. 9, t. 1, f. 10–12; Freshw. Alg. N. Zeal. 1888, p. 68; Borge, Süssw. Chlor. Archang. 1894, p. 15.

Cells longer than in the type, 12–18 times longer than their diameter, somewhat variable in size, ventral inflation less prominent, apices subtruncate; 23–34 striæ visible across the cell.

Zygospore double, each part ovoid-globose, smooth and thick-walled.

Length 306–700 μ; breadth 24–44 μ; breadth of apices 6–11·5 μ; diam. zygosp. 56·5–80 μ.

ENGLAND.—Near Bowness, and Loughrigg, Westmoreland! Hawkshead, Lancashire! Puttenham and Thursley Commons, Surrey! New Forest, Hants. (with zygosp.)!

IRELAND.—Lough Aunierin, Galway! Cromagloun, Kerry!

Geogr. Distribution.—Bohemia in Austria. Sweden. N. Russia. Ceylon. Siam. Singapore. New Zealand. Australia. Sandwich Is. United States.

This variety is widely distributed in many parts of the world and exhibits considerable variation. It is more tumid in the ventral margin, more attenuated towards the extremities, and more finely striated than *Cl. lineatum* Ehrenb. It resembles very closely *Cl. decorum* Bréb., and should be carefully compared with that species.

56. **Closterium decorum** Bréb.

(Pl. XVII, figs. 7, 8; Pl. XXVIII, figs. 1–3.)

Closterium decorum Bréb. Liste Desm. 1856, p. 151, t. 2, f. 39; Arch. in Pritch. Infus. 1861, p. 749; Rabenh. Flor. Europ. Algar. III, 1868, p. 137; Kirchn. Alg. Schles. 1878, p. 139; ? Wolle, Desm. U.S. 1884, p. 43, t. 7, f. 1; Hansg. Prodr. Algenfl. Böhm. 1888, p. 181; Nordst. Freshw. Alg. N. Zeal. 1888, p. 67; De Toni, Syll. Alg. 1889, p. 835; Roy & Biss. Scott. Desm. 1894, p. 244; Nordst. Index Desm. 1896, p. 98; West & G. S. West, Alga-fl. Yorks. 1900, p. 51.

Cl. crassum Delp. Desm. subalp. 1877, p. 121, t. 18, f. 22–30; Hansg. Prodr. Algenfl. Böhm. 1888, p. 180. [This is not *Cl. crassum* Rabenh. 1863.]

Cl. Ralfsii Bréb. a. *Delpontei* Klebs, Desm. Ostpreuss. 1879, p. 17, t. 2, f. 5 *a*, 5 *c*, 6 *a*.

Cl. Delpontei Wolle in Bull. Torr. Bot. Club, 1885, p. 2; Wolle, Freshw. Alg. U.S. 1887, p. 25, t. 55, f. 9; De Toni, Syll. Alg. 1889, p. 832; Roy & Biss. Scott. Desm. 1894, p. 244; West & G. S. West, Some Desm. U.S. 1898, p. 283; Freshw. Alg. Ceylon, 1902, p. 128.
Arthrodia decora Kuntze, Revis. gen. plant. 1891, p. 883.
A. Delpontei Kuntze, l. c.

Cells generally large, 12–20 times longer than the irdiameter, curvature variable, often slightly or moderately curved, rarely somewhat sigmoid, outer margin from 20° to 55° of arc, inner margin concave, with the median portion slightly but broadly tumid, gradually attenuated towards the apices, which are somewhat drawn out and truncately rounded; cell-wall striated, with 14–18 striæ visible across the cell, straw-coloured or of a yellowish-brown colour; chloroplasts ridged, with a single series of six to eleven pyrenoids; terminal vacuoles with several moving granules.

Zygospore subglobose and smooth.

Distance between apices (length) 370–720 μ; breadth 25–46 μ; breadth of apices 6–10 μ.

ENGLAND.—Boston Spa, W. Yorks!

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Brin, Inverness; Bourtie and Slewdrum, Aberdeen; near Loch Mharc, and Forest of Athole, Perth; Glen Coe, Argyll; Glen Clova, Forfar (*Roy & Bissett*).

IRELAND.—Clough, Antrim!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Portugal. Norway. Sweden. Poland. N. Russia. Ceylon. Sumatra. Java. Australia. New Zealand. United States.

The figure given by Brébisson of *Cl. decorum* is not a good one, but at the same time it is sufficiently good to recognise its identity with *Cl. Delpontei* (Klebs) Wolle. We have given a copy of Brébisson's figures (Pl. XVII, figs. 7, 8) and of two of Delponte's figures (Pl. XXV, figs. 1, 2) for purposes of comparison with each other and with our own (Pl. XXV, fig. 3.

Cl. decorum is a very rare British species, although it is frequent in tropical and subtropical countries. It has a slight though variable curvature, and it also varies much in relative length and breadth.

Its nearest ally is *Cl. Ralfsii* Bréb. var. *hybridum* Rabenh., from which it differs in its greater curvature, its greater slenderness, especially towards the apices, and in its fewer striæ.

57. **Closterium laterale** Nordst.

(Pl. XXV, figs. 4, 5.)

Closterium laterale Nordst. in Wittr. & Nordst. Alg. Exsic. 1880, no. 383; fasc. 21, 1889, p. 46; De Toni, Syll. Alg. 1889, p. 848; G. S. West. Alga-fl. Cambr. 1899, p. 112.
Arthrodia lateralis Kuntze, Revis. gen. plant. 1891, p. 883.

Cells large, stout, 8–11 times longer than their diameter, slightly curved, outer margin 43°–65° of arc, inner margin broadly subtumid, gradually attenuated to the apices, which are truncate or subtruncate; cell-wall finely striated, 45–60 striæ visible across the cell, straw-coloured; chloroplasts with about ten ridges and a single series of many pyrenoids in each ridge; terminal vacuoles with about ten moving granules.

Zygospore unknown.

Length 284–535 μ; breadth 41–60 μ; breadth of apices 7–8 μ.

ENGLAND.—Dernford Fen, near Shelford, Cambridge! Tremethick Moor, Cornwall!

Geogr. Distribution.—Brazil.

58. **Closterium Kützingii** Bréb.

(Pl. XXV, figs. 6–11.)

Stauroceras intermedium Kütz. Spec. Alg. 1849, p. 166.
Closterium Kützingii Bréb. Liste Desm. 1856, p. 156, t. 2, f. 40; Kirchn. Alg. Schles. 1878, p. 141; Nordst. Alg. et Char. I, 1880, p. 1; Wolle, Desm. U.S. 1884, p. 47, t. 8, f. 8; Cooke, Brit. Desm. 1886, p. 34, t. 5, f. 3; Hansg. Prodr. Algenfl. Böhm. 1888, p. 183; Nordst. Freshw. Alg. N. Zeal. 1888, p. 70, t. 3, f. 20; De Toni, Syll. Alg. 1889, p. 850; West, Alg. W. Ireland, 1892, p. 125; Alg. Eng. Lake Distr. 1892, p. 720; Roy & Biss. Scott. Desm. 1894, p. 245; Nordst. Index Desm. 1896, p. 152; West & G. S. West, Alg. S. England, 1897, p. 482; G. S. West, Variation Desm. 1899; Alga-fl. Yorks. 1900, p. 57; Alg. N. Ireland, 1902, p. 24.
Cl. setaceum Ehrenb. b. *intermedium* Rabenh. Flor. Europ. Algar. III, 1868, p. 136.
Cl. rostratum Ehrenb. b. *Kützingii* Klebs, Desm. Ostpreuss. 1879, p. 18.
Arthrodia Kützingii Kuntze, Revis. gen. plant. 1891, p. 883.

Cells of medium size, 20–28 times longer than their greatest diameter, almost straight, median part of cell fusiform-lanceolate, outer and inner margins almost equally convex, attenuated towards each extremity into long, colourless, setaceous processes, apices slightly incurved, rounded, and often slightly swollen; cell-wall colourless or straw-coloured, striated, 10–18 striæ visible across the cell; chloroplasts with a median row of four or five pyrenoids, terminating at the base of the apical processes; terminal vacuoles large, situated at the base of the apical processes, and containing from six to nine moving granules.

Zygospore subrectangular, sides straight or concave, angles truncate or truncately rounded.

Length 370–520 (even up to 600) μ; breadth 16–23 μ; breadth of apices 2·8–3·8 μ; greatest breadth of zygospore 48–51 μ; shortest breadth of zygosp. 35–36 μ.

England.—Westmoreland (zygosp. from Blea Tarn)! Lancashire! W. and N. Yorks! Cheshire, with zygosp. (*Roy*). Leicester (*Roy*). Essex! Suffolk! Cambridge! Oxford (zygosp. from near Goring)! Surrey! Hants! (*Bennett*). Cornwall!

Wales.—Llyn Idwal!, Llyn Ogwen!, Capel Curig (with zygosp.)!, Llyn Gwynant!, and Llyn Padarn, Carnarvonshire! Llyn Coron, Anglesey!

Scotland.—Sutherland!, Ross, Inverness, Aberdeen!, Kincardine, Forfar!, Fife; zygosp. from near Gillan in Strachan, Kincardine (*Roy & Bissett*). Harris and Lewis, Outer Hebrides! In the plankton of Loch Tay and Loch Achray, Perth!, and of Loch Doon, Ayr!

Ireland.—Donegal! Galway! Kerry (zygosp. from Kylemore)!

Geogr. Distribution.—France. Germany. Austria and Galicia. Norway. Sweden. Bornholm. N. and Central Russia. Faeroes. Greenland. India. Ceylon. Siam. Australia. New Zealand. Central Africa (var.). Madagascar. United States. Brazil. Ecuador. Paraguay. Patagonia.

Cl. Kützingii is a more elegant species than *Cl. rostratum,* the actual body of the *Closterium* being proportionately smaller and the apical processes relatively longer. It is generally less curved than *Cl. rostratum*, and the cell-wall is more conspicuously striated. The angles of the zygospore are also more rounded.

Var. **vittatum** Nordst. (Pl. XXV, figs. 12, 13.)

Cl. Kützingii var. *vittatum* Nordst. 1887; Freshw. Alg. N. Zeal. 1888, p. 70, t. 3, f. 21; De Toni, Syll. Alg. 1889, p. 850.

Cell-wall costate, about 5 or 6 costæ visible across the cell.

Zygospore precisely similar to that of the type.

Length 330–430 μ; breadth 13·5–18 μ.

ENGLAND.—Near Goring, Oxford (with zygosp.)!

Geogr. Distribution.—New Zealand.

This is a very striking variety which we have only obtained once. The proportions of the vegetative cells and the form of the zygospore are exactly like those of typical *Cl. Kützingii.*

59. **Closterium rostratum** Ehrenb.

(Pl. XXVI, figs. 1–5.)

Closterium rostratum Ehrenb. Entwick. Lebends. d. Infus. 1832, p. 67; Infus. 1838, p. 97, t. 6, f. x; Menegh. Synops. Desm. 1840, p. 234; Hass. Brit. Freshw. Alg. 1845, p. 373, t. 87, f. 6; Ralfs, Brit. Desm. 1848, p. 175, t. 30, f. 3; De Bary, Conj. 1858, p. 50, 54, t. 5, f. 26-30; Arch. in Pritch. Infus. 1861, p. 749, t. 3, f. 44; Rabenh. Flor. Europ. Alg. III, 1868, p. 135; Delp. Desm. subalp. 1877, p. 118, t. 17, f. 63–68 μ; Kirchn. Alg. Schles. 1878, p. 141; Wolle, Desm. U.S. 1884, p. 46, t. 8, f. 1–3; Cooke, Brit. Desm. 1886, p. 33, t. 14, f. 3; Hansg. Prodr. Algenfl. Böhm. 1888, p. 183; De Toni, Syll. Alg. 1889, p. 851; West, Alg. W. Ireland, 1892, p. 125; Roy & Biss. Scott. Desm. 1894, p. 248; Nordst. Index Desm. 1896, p. 225; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 57; Alg. N. Ireland, 1902, p. 24.
Cl. Acus Nitzsch in Kütz. Syn. Diat. 1834, p. 595, t. 18, f. 81.
Cl. caudatum Corda in Alm. d. Carlsbad. 1835, p. 190, 209, t. 5, f. 66.
Cl. rostratum a. *typicum* Klebs, Desm. Ostpreuss. 1879, p. 18.
Arthrodia rostrata Kuntze, Revis. gen. plant. 1891, p. 884.

Cells of medium size, 12–18 times longer than their greatest diameter, slightly curved, median part of cell fusiform-lanceolate, inner margin more convex than outer margin, extremities prolonged into long, colourless processes which are slightly incurved, apices obtuse and slightly dilated; cell-wall straw-coloured, finely striated, 25–27 striæ visible across the cell; chloroplasts with four or five pyrenoids; terminal vacuoles large, situated within the base of the apical processes, and containing from twelve to fifteen moving granules.

Zygospore somewhat rectangular, with hollow sides, angles truncate and concave.

Length 246–530 μ; breadth 19–30 μ; breadth of apices 3·4–5 μ; maximum breadth of zygospore 70–77 μ; minimum breadth of zygosp. 35–40 μ.

ENGLAND.—Cumberland (with zygosp.)! Westmoreland (*Ralfs*); with zygosp.! Lancashire! (*Ralfs*). W. (with zygosp.) and N. Yorks! Cheshire (*Ralfs*). Leicester (*Roy*). Lincolnshire! Cambridge! Warwick (*Wills*). Gloucester (*Ralfs*). Surrey (with zygosp.)! Sussex (*Ralfs*). Kent! (*Ralfs*). Hants! (*Bennett*). Devon! Cornwall (*Ralfs*); with zygosp.!

WALES.—Fairly general!

SCOTLAND.—General! (*Roy & Bissett*). Lewis, Outer Hebrides! Orkneys! Often in the freshwater plankton.

IRELAND.—Donegal! Galway! Kerry! Dublin and Wicklow (*Archer*). Antrim!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Portugal. Norway. Sweden. Bornholm. Poland. N., Central, and S. Russia. Finland. Faeroes. Iceland. Nova Zembla. Greenland. Siberia. Japan. Ceylon (form). E. Africa. United States. Brazil. Ecuador. Paraguay.

This species is generally distributed all over the British Islands, and in boggy ditches and ponds it often occurs in abundance. It is a stout species and is very frequently obtained in the conjugated state, particularly in the south of England. The apical processes are much shorter and more robust than those of *Cl. Kützingii*, and the cell-wall is more finely and delicately striated.

Var. **brevirostratum** West. (Pl. XXVI, figs. 6–8.)

Cl. rostratum var. *brevirostratum* West, Desm. Mass. 1889, p. 17, t. 2, f. 9; Nordst. Index Desm. 1896, p. 225; West & G. S. West, Alg. S. England, 1897, p. 482.

Cells with shorter apical processes than in the typical form, the body of the cell being gradually attenuated to the apices; striæ often scarcely discernible.

Length 188–365 μ; breadth 18–27 μ; maximum breadth of zygospore 73–77 μ; minimum breadth of zygosp. 50–66 μ.

ENGLAND.—Esher West-end Common, and Wimbledon Common (with zygosp.), Surrey!

Geogr. Distribution.—Germany. Portugal. United States.

60. **Closterium setaceum** Ehrenb.

(Pl. XXVI, figs. 9–13.)

Closterium setaceum Ehrenb. 1834; Infus. 1838, p. 97, t. 6, f. ix; Menegh. Synops. Desm. 1840, p. 235; Hass. Brit. Freshw. Alg. 1845, p. 373, t. 87, f. 7; Ralfs, Brit. Desm. 1848, p. 176, t. 30, f. 4; Arch. in Pritch. Infus. 1861, p. 750; Rabenh. Flor. Europ. Algar. III, 1868, p. 136; Kirchn. Alg. Schles. 1878, p. 142; Wolle, Desm. U.S. 1884, p. 47, t. 8, f. 6, 7, 9–11; Cooke, Brit. Desm. 1886, p. 34, t. 14, f. 4; Hansg. Prodr. Algenfl. Böhm. 1888, p. 184; De Toni, Syll. Alg. 1889, p. 850; Roy & Biss. Scott. Desm. 1894, p. 249; Nordst. Index Desm. 1896, p. 232; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 57; Alg. N. Ireland, 1902, p. 24.

Cl. rostratum Ehrenb. c. *setaceum* Klebs, Desm. Ostpreuss. 1879, p. 18.

Arthrodia setacea Kuntze, Revis. gen. plant. 1891, p. 884.

Cells small, very slender, almost straight, 25–36 times longer than their greatest diameter, median portion of cell small, fusiform-lanceolate, both margins equally convex, extremities prolonged into slender, setaceous, colourless processes, which are slightly incurved and obtuse at the apices; each apical process is about three-eighths the length of the cell; cell-wall colourless or pale straw-coloured, finely striated, about 13 fine striations visible across the cell; chloroplasts with two pyrenoids; terminal vacuoles within the base of the apical processes, with three or four moving granules.

Zygospores subquadrate or cruciform, with deeply concave sides and truncate angles.

Length 227–450 μ; breadth 7·5–12·5 μ; breadth of apices 0·7–1·5 μ; breadth of zygosp. 30–32 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W. and N. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Warwick (*Wills*). Gloucester (*Ralfs*). Surrey (zygosp. from Thursley Common)! Sussex (*Ralfs*). Hants (*Bennett*). Devon (*Bennett*). Cornwall! (*Marquand*).

WALES.—Bettws-y-coed (*Roy*), Capel Curig! (*Cooke & Wills*), near Dolbadarn Castle!, and Llyn Padarn!, Carnarvonshire! Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—Ross, Inverness, Aberdeen, Kincardine, Forfar, Perth!, Argyll (*Roy & Bissett*). In the plankton of Loch Doon, Ayr (with zygosp.)! Sutherland! Harris and Lewis (not uncommon in the plankton; with zygosp. from near Balallan), Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Italy. Norway. Sweden. Denmark. Bornholm. N. and S. Russia. Japan. Ceylon. Sumatra. Australia. Madagascar. United States.

Cl. setaceum is much the slenderest of the "beaked" *Closteria*. The body of the cell is relatively very small, and the apical processes are long and very thin. The striolations on the cell-wall are very faint and in some of the smaller specimens are scarcely evident.

It is a much rarer species than either *Cl. rostratum* or *Cl. Kützingii*.

EXCLUDED SPECIES.

Closterium subtile Bréb. Liste Desm. 1856, p. 155, t. 2, f. 48. For the most part Algæ recorded under this name have been species of *Rhaphidium* (or *Ankistrodesmus*).

Closterium Griffithii Berk. in Ann. Mag. Nat. Hist. 1854, p. 256, t. 14, f. 2 (= *Rhaphidium* sp.).

B. Point of division always fixed (at the isthmus).

Tribe 5. COSMARIEÆ.

The Desmids of this tribe exhibit great diversity of size and form, and they possess at least three planes of symmetry. Most of them are solitary, but others are colonial, forming filamentous or more or less spherical aggregates. The cell-wall consists of two firm layers furnished with minute pores. The outer layer is frequently ornamented with spines, warts, granules, or other excrescences, and the cell itself is often lobed.

No periodical growth takes place, the cell becoming adult very soon after division by the mature growth of the younger semicell.

The wall of the older semicell overlaps the wall of the younger semicell, and the edges of both new and old walls are bevelled so as to fit firmly together and at the same time present a plane surface. Thus, the two semicells, which are of different ages, are firmly joined along an oblique plane which runs round the isthmus.

It is much the most important tribe of the Desmidiaceæ, and it includes some of the largest and best-known genera.

The three genera *Streptonema*, *Desmidium*, and *Gymnozyga* are at once separated from the rest of the genera in this tribe by a peculiarity in the division of their cells, a girdle-like thickening being developed from the point of division at the isthmus, which projects backwards into each of the older semicells during division.

Section a. The cell-wall at the point of division (which is always at the isthmus) remains perfectly plane during division.

Genus 10. DOCIDIUM Bréb. 1844; em. Lundell, 1871.

Bréb. in Dict. univ. hist. nat. 1844, p. 92.
Lund. Desm. Suec. 1871, p. 88 [characters more strictly drawn up].

Cells straight, much elongated, more or less cylindrical, circular when viewed from the apex, slightly constricted in the middle; apices truncate and smooth; base of each semicell inflated and longitudinally plicate; one axile chloroplast in each semicell, with several irregular ridges, often partially applied to the cell-wall, and containing a number (about 6–8) of pyrenoids disposed in a more or less median series; with no conspicuous vacuole near the apex; cell-wall smooth, faintly punctate, or delicately striolate.

Much confusion has at different times existed concerning the genera *Docidium* and *Pleurotænium*, and they are yet regarded by many authors as unworthy of separation. For some years past we have accepted the characters of the genus *Docidium* as they were laid down by Lundell in 1871. The genus thus includes a few species which are marked off from species of the genus *Pleurotænium* by very decisive characters, the most important of which are the central or axile chloroplasts and the plication of the base of the semicells.

The most important feature of the genus is undoubtedly the *plicated base of the semicells accompanied by a truncate, smooth apex.*

There are only three British species.

1. **Docidium Baculum** Bréb.

(Pl. XXVII, figs. 1–6.)

? ***Closterium Baculum*** **Bréb. Alg. Falaise, 1835, p. 59, t. 8.**
Docidium Baculum **Bréb. in Dict. univ. hist. nat. 1844, p. 92; Bréb. in Ralfs' Brit. Desm. 1848, p. 158, t. 33, f. 5; Arch. in Pritch. Infus. 1861, p. 745, t. 3, f. 38; Lund. Desm. Suec. 1871, p. 88; Kirchn. Alg. Schles. 1878, p. 144; Cooke, Brit. Desm. 1886, p. 16, t. 7, f. 4; Hansg. Prodr. Algenfl. Böhm. 1888, p. 188; De Toni, Syll. Alg. 1889, p. 872; Börg. Desm. Brasil. 1890, p. 933; West, Alg. W. Ireland, 1892, p. 117; Roy & Biss. Scott. Desm. 1894, p. 241; West & G. S. West, Alg. Madag. 1895, p. 44, t. 5, f. 30; Some N. Amer. Desm. 1896, p. 234, t. 12, f. 35; Nordst. Index Desm. 1896, p. 55; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 58; Alg. N. Ireland, 1902, p. 25; Freshw. Alg. Ceylon, 1902, p. 141.**
Closterium Sceptrum **Kütz. Phycol. germ. 1845, p. 133.**
Penium Baculum **Kütz. Spec. Alg. 1849, p. 168.**

Pen. (*Docidium*) *Sceptrum* Kütz. Spec. Alg. 1849, p. 168.
Pleurotænium Baculum (Bréb.) De Bary, Conj. 1858, p. 75; Delp. Desm. subalp. 1877, p. 130, t. 20, f. 12–16.

Cells small, narrowly subcylindrical, 15–25 times longer than their diameter; semicells subcylindrical, with a prominent basal inflation, which is plicated and furnished with a ring of basal granules (of which from five to seven are visible across the cell), with a slight constriction above the basal inflation; gradually or sometimes scarcely attenuated from the middle of the semicell to the apex, which is smooth and truncate; cell-wall smooth.

Zygospore unknown.

Length 148–262 (even up to 348) μ; breadth of basal inflation 9·5–13 μ; breadth of apex 4·8–10 μ.

ENGLAND.—Westmoreland! (*Ralfs*). W. and N. Yorks! Lancashire (*Ralfs*). Gloucester (*Ralfs*). Sussex (*Ralfs*). Hants! Cornwall (*Ralfs*).

WALES.—Capel Curig! (*Cooke & Wills*), and near Dolbadarn Castle!, Carnarvonshire. Llyn Coron, Anglesey!

SCOTLAND.—Widely distributed, but scarce! (*Roy & Bissett* state "general"). Not uncommon in the Outer Hebrides!

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Down!

Geogr. Distribution.—France. Germany. Galicia in Austria. Hungary. Italy. Portugal. Norway. Sweden. Denmark. Bornholm. N. and S. Russia. India. Ceylon. Java. Madagascar. E. Africa. United States. Brazil. Guiana. Paraguay.

Although this is the most frequent British species of the genus, it is nevertheless somewhat rare. It is rarely found except in situations in which Desmids are abundant.

2. **Docidium undulatum** Bail.

(Pl. XXVII, figs. 7–10.)

Docidium undulatum Bail. Microscop. observ. 1850, p. 36, t. 1, f. 2; Arch. in Pritch. Infus. 1861, p. 745; Rabenh. Flor. Europ. Algar. III, 1868, p. 145; De Toni, Syll. Alg. 1889, p. 874; Turner, Freshw. Alg. E. India, 1893, p. 35, t. 4, f. 16.

Pleurotænium undulatum Rabenh. Flor. Europ. Alg. III, 1868, p. 104.
Docidium dilatatum Lund. Desm. Suec. 1871, p. 88, t. 5, f. 12; Kirchn. Alg. Schles. 1878, p. 144; Wolle, Desm. U.S., 1884, p. 50, t. 50, f. 32; De Toni, Syll. Alg. 1889, p. 873; West, Alg. W. Ireland, 1892, p. 118, t. 19, f. 5; West & G. S. West, Some Desm. U.S. 1898, p. 285.

Cells small, elongated, 14–20 times longer than their diameter; semicells with 7–8 nodulose undulations along each margin; apices dilated, truncate, with rounded angles; basal plications 11–12, furnished with granules as in *D. Baculum* (about 7 visible across the base of the semicell); cell-wall smooth.

Zygospore unknown.

Length 178–246 μ; breadth (maximum) 12–16·5 μ; breadth of apices 11·5–15 μ.

SCOTLAND.—Poolewe, Ross; Glen Dole, Forfar; Rannoch, Perth (*Roy & Bissett*). Loch Morar, Inverness! Rhiconich, Sutherland! Near Tarbert, Harris; near Balallan and near Callernish, Lewis, Outer Hebrides!

IRELAND.—Near Oughterard, Kylemore, and Oorid Lough, Galway! Glengariff (*Archer*), Cromagloun, Torc Mt., and Glen Caragh, Kerry!

Geogr. Distribution.—France. Norway. Sweden. United States. Guiana.

The Desmid we have placed under *Docidium undulatum* Bail. is identical with that recorded by Lundell from Sweden under the name of "*Docidium dilatatum.*" It agrees much more closely, however, with *Docidium undulatum* Bail. than with the plant recorded by Cleve as *Pleurotænium dilatatum.* It possesses the undulated semicells exactly as figured by Bailey, and also the *dilated, truncate apices.* Bailey remarked that both the base and apex of the semicells were plicated, but all the British and American specimens we have examined have only a plicated base. In fact, we know of no *Docidium* with a plicated apex. Wolle's figure of *Docidium undulatum* (Desm. U.S. 1884, pl. ii, fig. 5) does not represent Bailey's species.

D. undulatum is a very rare British species, and appears to be principally confined to the western areas of Scotland and Ireland. In these districts it is sometimes met with abundantly; it is quite a characteristic species and seems to be an Atlantic type.

Forma **perundulata** *nob.* (Pl. XXVII, fig. 11.)

Docidium dilatatum Lund. forma, West, Alg. W. Ireland, 1892, p. 118, t. 19, f. 6.

Cells rather more elongate; semicells with 10–13 undulations along each lateral margin.

Length 200–262 μ; breadth (maximum) 12·5–14 μ; breadth of apices 11–12 μ.

IRELAND.—Cromagloun, Kerry!

Geogr. Distribution.—United States.

Var. **dilatatum** (Cleve) *nob.* (Pl. XXVII, fig. 12.)

Pleurotænium dilatatum Cleve, Sverig. Desm. 1864, p. 494, t. 4, f. 6.
Docidium dilatatum Lund. var. *subundulatum* West, Alg. W. Ireland, 1892, p. 118, t. 19, f. 7.

Cells relatively a little shorter; semicells less deeply undulated, generally slightly tumid about the middle, and with a slight constriction above the basal undulation; cell-wall often strongly punctate.

Length 187–205 μ; breadth at base of semicells 15·5–16 μ; breadth at middle of semicells 16–17 μ; breadth of apices 13–14 μ.

SCOTLAND.—Rhiconich, Sutherland!

IRELAND.—Near Oughterard, Galway! Glen Caragh, Kerry!

Geogr. Distribution.—Sweden. Lapland in Russia.

The apices of this variety are as dilated and truncate as those of the type, but the marginal undulations are much less pronounced, and the semicells are slightly tumid.

3. **Docidium nobile** (Richt.) Lund.

(Pl. XXVII, figs. 13–15.)

Pleurotænium nobile Richter in Hedwigia, 1865, p. 129, f. 1–3; Rabenh. Flor. Europ. Algar. III, 1868, p. 142.
Docidium nobile (Richt.) Lund. Desm. Suec. 1871, p. 88; Arch. in Micr. Journ. xii, 1872, p. 86; Cooke, Brit. Desm. 1886, p. 13, t. 7, f. 3; De Toni, Syll. Alg. 1889, p. 873; Roy & Biss. Scott. Desm. 1894, p. 241.

Cells small, elongated, 10–12 times longer than their diameter; semicells very gradually tapering from base to apex, base distinctly plicated, lateral margins with about 8 undulations; apices not conspicuously dilated, convexo-truncate; cell-wall finely and densely longitudinally plicate-striate.

Zygospore unknown.

Length 210–260 μ; breadth 20–35 μ (*Richter*).

Length 175 μ; breadth 14 μ (*Lundell*).

SCOTLAND.—Poolewe, Ross; Cambus O'May, Aberdeen; Bishop's Dam and Dalbrake in Strachan, Kincardine; near Kingshouse, Argyll (*Roy and Bissett*).

IRELAND.—Glengariff, Kerry (*Archer*).

Geogr. Distribution.—Germany. Sweden. Poland.

We have never seen this species from any part of the world. It apparently differs from *D. undulatum* Bail. in being of stouter build, with less dilated apices, and in the structure of the cell-wall. We give Richter's and Lundell's measurements separately, as there is considerable discrepancy between them. The figures we give (Pl. XXVII, figs. 13–15) are careful copies of Richter's figures in 'Hedwigia.' These figures, according to Richter's stated magnification, measure 330–353 μ in length and 30–33 μ in breadth.

Genus 11. **PLEUROTÆNIUM** Näg. 1849.

Näg. Gatt. einz. Alg. 1849, p. 104.
Rabenh. Flor. Europ. Algar. III, 1868, p. 140
Kirchn. Alg. Schles. 1878, p. 144.
Hansg. Prodr. Algenfl. Böhm. 1888, p. 189.
De Toni, Syll. Alg. 1889, p. 895.

Cells straight, elongated and cylindrical, viewed from the end circular, slightly constricted in the middle, with a prominent and usually projecting suture; semicells commonly with an inflated base, which is never plicate, lateral margins straight, undulate, or nodulose; apices truncate or truncately rounded, frequently plicated round the periphery or furnished with a ring of tubercles; cell-wall rarely smooth, commonly punctate or minutely scrobiculate, sometimes granulose or papillate. Chloroplasts parietal, numerous, arranged in irregular longitudinal bands which are frequently broken up into small rhomboidal or lanceolate masses, each with a single pyrenoid.

This genus is distinguished from *Docidium* by the entire absence of plications at the base of the semicells, by the commonly tuberculated or peripherally plicated apices, and by the nature of the chloroplasts.

Few species of the genus are destitute of tubercles round the apex, and in some, such as *Pl. Sceptrum*, the tubercles are replaced by sharp teeth. The genus is poorly represented in the British Islands, being most abundantly met with in the tropics. Many of the tropical species are very prettily marked, and some of them are attached by their tuberculated apices so as to form long filamentous colonies.

The nature of the parietal chloroplasts is well illustrated by the drawing of the semicell of *Pl. coronatum* on Pl. XXVIII (fig. 4). The central cavity of the cylindrical semicells is occupied by a number of large fluid vacuoles, the terminal one frequently containing a mass of small moving granules. Under abnormal conditions these granules make their appearance in all the vacuoles of the cell.

At the isthmus or point of junction of the old and new semicells is a thickening of the cell-wall, termed the *suture*. This projects evenly as a circular rim all round the middle of the cell, and as a rule the larger the species the more prominent the suture. It is of no use as a specific character.

There are nine British species,* which are best arranged as follows:—

SECTION A. Cells cylindrical or slightly attenuated; end view circular.

* Cell-wall smooth, punctate, or granulate.
  † Apices furnished with a ring of tubercles.
    1. *Pl. coronatum.*
    2. *Pl. eugeneum.*
    3. *Pl. truncatum.*
    4. *Pl. Ehrenbergii.*
    5. *Pl. tridentulum.*
  †† Apices without tubercles.
    6. *Pl. Trabecula.*
    7. *Pl. maximum.*
** Cell-wall papillate.
    8. *Pl. Hutchinsonii.*

SECTION B. Cells furnished with rings of nodules; end view sinuate-stellate.
    9. *Pl. nodosum.*

---

* We regard Bailey's "*Docidium hirsutum*," which is mentioned in Cooke's British Desmids (p. 17, t. 7, f. 5) and doubtfully recorded by Roy from Scotland, as a defective representation of a species of *Gonatozygon*.

1. **Pleurotænium coronatum** (Bréb.) Rabenh.

(Pl. XXVII, figs. 16–18; Pl. XXVIII, fig. 4.)

Docidium coronatum Bréb. in Ralfs' Brit. Desm. 1848, p. 217, t. 35, f. 6; Arch. in Pritch. Infus. 1861, p. 745; Cooke, Brit. Desm. 1886, p. 13, t. 7, f. 1; West, Alg. N. Wales, 1890, p. 284; Roy in Journ. Bot. 1890, p. 335; Roy & Biss. Scott. Desm. 1894, p. 241.

Pleurotænium coronatum (Bréb.) Rabenh. Flor. Europ. Algar. III, 1868, p. 143; Kirchn. Alg. Schles. 1878, p. 144; Hansg. Prodr. Algenfl. Böhm. 1888, p. 190; De Toni, Syll. Alg. 1889, p. 901; West, Alg. W. Ireland, 1892, p. 118, t. 19, f. 8-10; Nordst. Index Desm. 1896, p. 83; West, Alg. Eng. Lake Distr. 1892, p. 719; West & G. S. West, Alg. S. England, 1897, p. 482; Alga-fl. Yorks. 1900, p. 58; Alg. N. Ireland, 1902, p. 26.

Pl. nodulosum var. *coronatum* (Bréb.) Boldt in Bih. till Sv. Vet.-Akad. Handl. Bd. 13, 1888, no. 6, p. 59.

Cells large, 9–12 times longer than their diameter; semicells very slightly and gradually attenuated from base to apex, with a prominent basal inflation and several smaller undulations immediately above it, upper half of lateral margins straight; apices truncate, with a peripheral ring of 10–12 large, conical or flattened tubercles (5–6 visible across the apex); cell-wall scrobiculate.

Zygospore unknown.

Length 430–591 μ; breadth at base of semicells 38–70 μ; breadth at apex of semicells 37–53 μ.

ENGLAND.—Brother's Water and Helvellyn, Westmoreland! Pilmoor, N. Yorks! Thursley Common, Surrey! Enbridge Lake (*Roy*) and New Forest!, Hants.

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Inverness!, Aberdeen, Forfar, Perth!, Fife (*Roy & Bissett*). Sutherland! Plankton of Loch Ruar and Loch Nan Cuinne, Sutherland; and of Loch Fadaghoda, Lewis, Outer Hebrides!

IRELAND.—Near Lough Magrath, Donegal! Loughs Aunierin, Derryclare, and Shannacloontippen, Galway! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Galicia in Austria. Norway. Sweden. Central and E. Africa. United States. Brazil.

Var. **fluctuatum** West. (Pl. XXVIII, figs. 1, 2.)

Pleurotænium coronatum var. *fluctuatum* West, Alg. W. Ireland, 1892, p. 118, t. 19, f. 11.

Cells larger than in the typical form, $11\frac{1}{2}$–14 times longer than their diameter; lateral margins of the semicells undulate along their entire length; basal inflation large, as in the type; apical tubercles large, 11–15 in number (6–8 visible).

Length 670–832 μ; breadth at base of semicells 55–72 μ, in middle of semicells 43–53 μ, at apex 50–53 μ.

Scotland.—Rhiconich, Sutherland! Plankton of Loch Fadaghoda, Lewis, Outer Hebrides!

Ireland.—Lough Aunierin, Galway!

This is the largest British *Pleurotænium* and is a very handsome Desmid. *Pleurotænium coronatum* is far from common and the var. *fluctuatum* is very rare. In all forms of this species the cell-wall is very thick and is finely scrobiculate.

Var. **robustum** West. (Pl. XXVIII, fig. 3.)

Pleurotænium coronatum var. *robustum* West, Alg. W. Ireland, 1892, p. 118, t. 19, f. 12; West & G. S. West, Alg. N. Ireland, 1902, p. 26.

Cells shorter than in the typical form, about 8 times longer than their diameter; semicells with the lateral margins subundulate, distinctly and somewhat suddenly attenuated at the apex; apical tubercles large, 10 in number (5 visible).

Length 460 μ; breadth at base of semicells 57 μ, in middle of semicells 55 μ, at apex 48 μ.

Ireland.—Dungloe and Sproule's Lough, Donegal! Lough Derryclare, Galway!

Var. **nodulosum** (Bréb.) West. (Pl. XXVIII, figs. 5–8.)

Docidium nodulosum Bréb. in Ralfs' Brit. Desm. 1848, p. 155, t. 26, f. 1; Arch. in Pritch. Infus. 1861, p. 745; Cooke, Brit. Desm. 1886, p. 15, t. 6, f. 3.

Pleurotænium nodulosum (Bréb.) De Bary, Conj. 1858, p. 75; Delp. Desm. subalp. 1877, p. 126, t. 19, f. 1–6; Kirchn. Alg. Schles. 1878, p. 144; Hansg. Prodr. Algenfl. Böhm. 1888, p. 189, f. 112; De Toni, Syll. Alg. 1889, p. 900.

Docidium coronatum var. nodulosum Roy, Freshw. Alg. Enbridge Lake and Vicinity, 1890, p. 335.

Pleurotænium coronatum var. nodulosum West, Alg. W. Ireland, 1892, p. 119; Alg. Eng. Lake Distr. 1892, p. 719; West & G. S. West, Alg. S. England, 1897, p. 482; G. S. West, Alga-fl. Cambr. 1899, p. 113; West & G. S. West, Alga-fl. Yorks. 1900, p. 59.

Semicells with the basal inflation slightly reduced and with the apical tubercles much reduced (rarely wanting).

Length 335–494 μ; breadth at base of semicells 43–60 μ, at apex 24–41 μ.

ENGLAND.—Westmoreland! (*Ralfs*). W. and N. Yorks! Cambridge! Warwick (*Wills*). Gloucester (*Ralfs*). Surrey! Sussex (*Ralfs*). Hants! Cornwall! (*Marquand*).

WALES.—Capel Curig! (*Cooke & Wills*), and near Dolbadarn Castle!, Carnarvonshire. Dolgelly, Merioneth (*Ralfs*).

SCOTLAND.—General! (*Roy & Bissett*). Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Cloonee Lough, and 8 miles S. of Kenmare, Kerry! Dublin and Wicklow (*Archer*). Clough, Antrim!

Geogr. Distribution.—France. Germany. Galicia in Austria. Hungary. Italy. Norway. Sweden. Bornholm. Central and S. Russia. India. Central Africa (form). Sandwich Islands. United States. Brazil.

This is the most abundant and widely distributed of the varieties of *Pleurotænium coronatum*. It differs little from the type, the most important distinction being the great reduction in the size of the apical tubercles, but every gradation exists between the condition typical of *Pleurotænium coronatum* and a form in which the tubercles are completely absent.

Rabenhorst identifies "*Docidium nodulosum* Bréb." with "*Closterium crenulatum* Ehrenb.," referring to both under the name of *Pleurotænium crenulatum* (Ehrenb.) Rabenh. We do not think, however, that Ehrenberg's "*Closterium crenulatum*" is correctly identified with *Docidium nodulosum* Bréb. Certainly the plants described and figured by Wolle as "*Docidium crenulatum*" are not identical with Brébisson's species, although Wolle gives Brébisson's name as a synonym.

Docidium coronatum var. *undulatum* Hieronymus (Conj. in Engl. Pflanzenw. Ost-Afrik. 1895, p. 19) does not appear to differ in any marked degree from an ordinary form of the type. The measurements given by Schmidle (Ost-Afrika Desmid. 1898, p. 23) as "Diam. 30 μ; long. 180 μ," must refer to one semicell only, as is obviously shown by his figure (t. i, f. 11).

Turner (in the Naturalist, Oct. 1887, p. 290) records *Docidium nodulosum* var. *labiatum*, but we do not quite comprehend the distinguishing features of this form. He suggests that there is an apical incision, but does not definitely say so (*vide* Naturalist, Sept. 1887, p. 275); neither do we know of anything of the nature of an apical incision in any species of this genus. We recorded Turner's form, which was from Gormire, N. Yorks., in the 'Alga-flora of Yorkshire' (p. 59) as *Pleurotænium coronatum* var. *nodulosum* forma *labiata*.

2. **Pleurotænium eugeneum** (Turn.) *nob.*

Docidium eugeneum Turn. Freshw. Alg. E. India, 1893, p. 30, t. 3, f. 3; Nordst. Index Desm. 1896, p. 120.

Cells large, elongated and cylindrical, 16–18 times longer than their diameter; semicells with a prominent basal inflation, lateral margins slightly sinuate, very slightly attenuated towards the apex, which is rotundo-truncate and furnished with a ring of 20–24 pyriform tubercles (11 visible across the apex); cell-wall smooth.

Zygospore unknown.

Length 670–720 μ; breadth at base of semicells 28–32 μ; breadth at apex 24 μ.

Geogr. Distribution.—India.

The typical form does not occur in Britain.

Turner's dimensions do not agree with the size and proportion of his figure. The above measurements are those given by Turner in his text, but his figure measures: Length 712 μ; breadth at base of semicells 45 μ, at apex 31 μ. These are much more in accordance with the proportions of the British forms.

Forma **Scotica** *forma nov.* (Pl. XXIX, fig. 1.)

Cells about 17 times longer than their diameter, scarcely attenuated; semicells with three or four smaller undulations above the basal inflation, the rest of the lateral margins straight; with a ring of 20 elongated tubercles round the apex (11 visible); cell-wall minutely punctate.

Length 632 μ; breadth at base of semicells 37 μ, at apex 28 μ.

SCOTLAND.—Rhiconich, Sutherland!

Forma **Cambrica** *forma nov.* (Pl. XXIX, fig. 2.)

Cells about 14 times longer than their diameter, scarcely attenuated; semicells with a second large inflation above the basal inflation, the rest of the lateral margins straight; with a ring of 20 elongated tubercles round the apex (11 visible); cell-wall minutely punctate.

Length 665 μ; breadth at base of semicells 47 μ, at apex 30 μ.

WALES.—Capel Curig, Carnarvonshire!

3. **Pleurotænium truncatum** (Bréb.) Näg.

(Pl. XXIX, figs. 3, 4.)

Closterium truncatum Bréb. in Cheval. microscop. et leur usage, Paris, 1839, p. 272; Bréb. in Menegh. Synops. Desm. 1840, p. 235.

Docidium truncatum Bréb. in Ralfs' Brit. Desm. 1848, p. 156, t. 26, f. 2; Arch. in Pritch. Infus. 1861, p. 745; Cooke, Brit. Desm. 1886, p. 15, t. 6, f. 4; Roy & Biss. Scott. Desm. 1894, p. 242.

Pleurotænium ? truncatum (Bréb.) Näg. Gatt. einz. Alg. 1849, p. 104; De Bary, Conj. 1858, p. 75; Rabenh. Flor. Europ. Algar. III, 1868, p. 142; Delp. Desm. subalp. 1877, p. 127, t. 19, f. 7–11; Hansg. Prodr. Algenfl. Böhm. 1888, p. 190; De Toni, Syll. Alg. 1889, p. 897; West, Alg. W. Ireland, 1892, p. 119; Lütkem. Desm. Attersees, 1893, p. 546; West & G. S. West, Alg. S. England, 1897, p. 483; Alga-fl. Yorks. 1900, p. 59.

Cells large, 6–8 (rarely up to $10\frac{1}{2}$) times longer than their diameter; semicells somewhat tumid, generally a little broader in the middle than at the base, gradually and considerably attenuated from the middle to the apex, with a slight but distinct basal inflation; apices truncate or convexo-truncate, with a ring of 13–15 small, depressed, apical tubercles (7–8 visible across the apex); cell-wall punctate.

Zygospore unknown.

Length 380–560 (very rarely up to 700) μ; breadth in middle of semicells (maximum breadth) 54–75 μ; breadth at apices 29–40 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W. and N. Yorks! Leicester (*Roy*). Suffolk! Warwick! (*Wills*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Hants. (*Roy*). Cornwall! (*Ralfs*).

WALES.—Capel Curig! (*Cooke & Wills*), Snowdon (at over 3,000 ft.)!, and Llyn Padarn!, Carnarvonshire.

SCOTLAND.—General! (*Roy & Bissett*). Outer Hebrides! Shetlands!

IRELAND.—Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*).

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Norway. Sweden. Denmark. Bornholm. Poland. N. Russia. Nova Zembla. Spitzbergen. Greenland. India. New Zealand. United States. Brazil. Paraguay.

Var. **crassum** Boldt.

Pleurotænium truncatum var. *crassum* Boldt, Siber. Chlorophy. 1885, p. 121, t. 6, f. 44; West & G. S. West, Alga-fl. Yorks. 1900, p. 59.
Pl. Brefeldii Istvanffi, Diag. præv. Alg. nov. Hungar. 1887, p. 240.

Cells shorter than in the typical form, only 4 times longer than their diameter; semicells more tumid, without basal inflation, and without apical tubercles.

Length 255 μ; maximum breadth 63 μ.

ENGLAND.—Gormire, N. Yorks (*Turner*).

Geogr. Distribution.—Hungary. Sweden. Nova Zembla. Siberia.

We think that Boldt's variety might perhaps be placed as a species, but as we have never seen a specimen of it we cannot pronounce a definite opinion on this point.

Var. **granulatum** West. (Pl. XXIX, figs. 7, 8.)

Pleurotænium truncatum var. *granulatum* West, New Brit. Freshw. Alg. 1894, p. 3; Roy & Biss. Scott. Desm. 1894, p. 242.

A variety with the cell-wall distinctly and irregularly granulate.

Length 405–465 μ; max. breadth 54–67 μ.

ENGLAND.—Borrowdale, Cumberland!

SCOTLAND.—Ben Laoigh, Perth!

Var. **Farquharsonii** (Roy & Biss.) *nob.* (Pl. XXIX, figs. 5, 6.)

Docidium Farquharsonii Roy, Freshw. Alg. Enbridge Lake and Vicin. 1890, p. 335; Roy & Biss. Scott. Desm. 1894, p. 241, t. 4, f. 1.

This variety differs only from the typical form in the somewhat sudden attenuation of the semicells near the apex; apical tubercles large and very depressed, 12–14 in number (7 or 8 visible across the apex).

Length 288–384 μ; max. breadth 48–53 μ; breadth at apices 22·5–28 μ.

ENGLAND.—Ball Hill Pond, Hants (*Roy*). Near Land's End, Cornwall!

SCOTLAND.—Near Springhill, Aberdeen; Muchalls, Kincardine; Balquhadly Hill in Fern, Forfar; Tent's Moor, Fife; Sheriffmuir near Dunblane, and Bracklin near Callander, Perth (*Roy & Bissett*).

4. **Pleurotænium Ehrenbergii** (Bréb.) De Bary.

(Pl. XXIX, figs. 9–11; Pl. XXX, fig. 1.)

Closterium Trabecula Ehrenb., 1830 [in part].

Docidium Ehrenbergii Bréb. in Dict. univ. hist. nat. 1844, p. 93; Ralfs, Brit. Desm. 1848, p. 157, t. 26, f. 4; Arch. in Pritch. Infus. 1861, p. 745, t. 2, f. 8-11; t. 3, f. 46, 47; Cooke, Brit. Desm. 1886, p. 14, t. 6, f. 1 *a*, *b*, *d*; West, Alg. N. Wales, 1890, p. 284; Roy & Biss. Scott. Desm. 1894, p. 241 (in part?).

Penium (*Docidium*) *Ehrenbergii* Kütz. Spec. Alg. 1849, p. 168.

Pleurotænium Ehrenbergii (Bréb.) De Bary, Conj. 1858, p. 75; Hansg. Prodr. Algenfl. Böhm. 1888, p. 189; De Toni, Syll. Alg. 1889, p. 896; West, Alg. W. Ireland, 1892, p. 119; Alg. Eng. Lake Distr. 1892, p. 719; Nordst. Index Desm. 1896, p. 114; West & G. S. West, Alg. S. England, 1897, p. 483; G. S. West, Alga-fl. Cambr. 1899, p. 113;

West & G. S. West, Alga-fl. Yorks. 1900, p. 58; Alg. N. Ireland, 1902, p. 26.
Docidium Ehrenbergii var. *tumidum* Turn. Freshw. Alg. E. India, 1893, p. 31, t. 4, f. 4.
D. quantillum Turn., l. c., 1893, p. 28, t. 2, f. 9; t. 4, f. 12.

Cells of medium size, rather narrow and subcylindrical, 15–20 times longer than their diameter; semicells somewhat variable in form, not at all or sometimes slightly attenuated from base to apex, with a distinct though small basal inflation and one undulation (sometimes two) immediately above it; apices truncate, bordered by a ring of conical or rounded tubercles, 7–10 in number (4 or 5 visible across the apex); cell-wall punctate.

Zygospore globose or ellipsoid-globose, smooth.

Length 240–480 μ; breadth at base of semicells 18–35 μ, at middle of semicells 16–26 μ, at apices 14·5–22 μ; diam. zygosp. 70–90 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W., N., and E. Yorks! Lancashire! Leicester (*Roy*). Essex! Cambridge! Oxford! Warwick (*Wills*). Gloucester (*Cooke*). Middlesex (*Cooke*). Surrey (zygosp. from Thursley Common)! Sussex (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*).

WALES.—General! (at 2,200 ft. on Glyder Fach, Carnarvonshire).

SCOTLAND.—General! (*Roy & Bissett*). Common in Outer Hebrides! Orkneys! Shetlands!

IRELAND.—General and abundant!

Geogr. Distribution.—France. Germany. Austria and Galicia. Hungary. Italy. Norway. Denmark. Bornholm. Poland. N. Russia. Nova Zembla. Siberia. Central China. India. Ceylon. Java. Sumatra. Samoa. Australia. New Zealand. Madagascar. E. & W. Africa. United States. Brazil. Patagonia.

Pl. Ehrenbergii is the most frequent of the British species of the genus, and it exhibits considerable variability in both form and size. The semicells are generally slightly attenuated from the base to the apex, but in some forms they are somewhat tumid, or the lateral margins may be parallel. There is one basal inflation with usually another smaller undulation just above it. The apical tubercles are never absent, but in rare instances they may be much reduced.

A curious form of this species is figured on Pl. XXX, fig. 2. The cells are larger than usual and there is a large inflation on each semicell above the basal inflation. The specimen was from Capel Curig, N. Wales; length 445 μ; breadth above basal inflation (max. breadth) 37–40 μ; breadth of apices 24 μ. We have noticed the same form from the plankton of Loch Fadaghoda, Lewis, Outer Hebrides.

Var. **granulatum** Ralfs.

Docidium Ehrenbergii var. *granulatum* Ralfs, Brit. Desm. 1848, p. 157, t. 33, f. 4; West, Alg. N. Wales, 1890, p. 284; Roy & Biss. Scott. Desm. 1894, p. 241; West & G. S. West, Alga-fl. Yorks. 1900, p. 58.

A variety with the cell-wall distinctly and coarsely granulate.

Length 350 μ; breadth at base of semicells 33 μ; breadth at apices 26 μ.

ENGLAND.—W. and N. Yorks! Sussex (*Ralfs*). Hants (*Roy*). Cornwall! (*Ralfs*).

WALES.—Capel Curig, Carnarvonshire!

SCOTLAND.—Aberdeen (*Roy & Bissett*). Perth!

Geogr. Distribution.—Bohemia in Austria.

Var. **elongatum** West. (Pl. XXX, fig. 3.)

Docidium Ehrenbergii var. *elongatum* West, Alg. N. Wales, 1890, p. 284.
Pleurotænium Ehrenbergii var. *elongatum* West, Alg. W. Ireland, 1892, p. 119.

Cells narrow and much elongated, about 25 times longer than the diameter.

Length 525–575 μ; breadth at base of semicells 23–26 μ, in middle 21–22·5 μ, at apices 17–19 μ.

WALES.—Capel Curig, Carnarvonshire!

IRELAND.—Clifden, Galway!

Var. **undulatum** Schaarschm.

Pleurotænium Ehrenbergii var. *undulatum* Schaarschm. Magyar. Desm. 1883, p. 278, t. 1, f. 21; Schmidle, Alg. aus Sumatra, 1895, p. 300 with fig.; West & G. S. West, Freshw. Alg. Ceylon, 1902, p. 145.

Cells larger than in the type, 20–23 times longer than their diameter; basal inflation prominent and lateral margins gently undulate from base to apex.

Length 600–700 μ; breadth in middle of semicells 28–30 μ, at apices 26–27 μ.

Geogr. Distribution.—Austria. Hungary. Sumatra.

The true var. *undulatum* Schaarschm. has not been observed in the British Isles, but a form has been found in Cambridgeshire which approaches very close to it (*vide* G. S. West, Alga-fl. Cambr. 1899, p. 113). The upper third of the semicells was destitute of undulations, otherwise it would not have differed from Schaarschmidt's variety; length 709 μ; breadth at base of semicells 40 μ, in middle of semicells 31 μ, at apices 27 μ. This form is figured on Pl. XXX, f. 4.

5. **Pleurotænium tridentulum** (Wolle) West.

(Pl. XXX, figs. 5, 6.)

Docidium tridentulum Wolle, in Bull. Torr. Bot. Club, 1882, p. 14; Desm. U.S. 1884, p. 52, t. 10, f. 10; De Toni, Syll. Alg. 1889, p. 874; Roy & Biss. Scott. Desm. 1894, p. 242; Nordst. Index Desm. 1896, p. 258.

D. Sceptrum Roy in Scott. Naturalist, 1883, p. 39. [This is not *Closterium Sceptrum* Kütz.]

Pleurotænium tridentulum (Wolle) West, Alg. W. Ireland, 1892, p. 120.

Penium tridentulum Eichl. & Racib., 1893; Eichler, Mat. flor. Miedz. 1894, p. 57.

Pleurotænium Sceptrum West & G. S. West, Some N. American Desm. 1896, p. 235, t. 13, f. 6; Some Desm. U.S. 1898, p. 285; Alg. N. Ireland, 1902, p. 26.

Cells rather small, narrow, about 20 times longer than their diameter; semicells gradually attenuated from base to apex, with a slight basal inflation, lateral margins straight; apices truncate, furnished with four sharp spines or teeth; cell-wall smooth.

Zygospore subglobose and smooth.

Length 211–320 μ; breadth at base of semicells 12·5–16 μ; breadth at apex 6·5–8·3 μ; diam. zygosp. 34 μ.

SCOTLAND.—Poolewe, Ross; Brin (*Roy & Bissett*) and Moidart, Inverness! Head of Glen Coe, and in Mull, Argyll (*Roy & Bissett*).

IRELAND.—Near Glenties, Donegal!

Geogr. Distribution.—Poland. India (form). W. Indies. United States.

This is one of the rarest British species of the genus, and is well characterised by its small size and apical teeth. The four apical teeth are not all in focus at the same time, and this led to an error in Wolle's original description, in which he mentions only three teeth. It is a decided western species in the British Isles. Some forms were noticed which were suddenly attenuated at about one fifth of the length of their semicells from the apices.

As this Desmid is not "*Closterium Sceptrum* Kütz. 1845," that species being *Docidium Baculum* Bréb., Roy's specific name "*Sceptrum*" cannot be accepted for the species, being one year subsequent to Wolle's *Docidium tridentulum*.

Var. **capitatum** West. (Pl. XXX, figs. 7, 8.)

Pleurotænium tridentulum var. *capitatum* West, Alg. W. Ireland, 1892, p. 120, t. 24, f. 12.
Pl. tridentulum var. *granulatum* West, l. c. p. 120.
Pl. Sceptrum West & G. S. West, var. *capitatum* West & G. S. West, Some N. Amer. Desm. 1896, p. 235, t. 13, f. 7, 8.

Cells more elongate than in the type, 26–27 times longer than their diameter; semicells gradually attenuated to the apices, which are subcapitate and rounded; cell-wall granulate except at the apices, which are smooth and furnished with the usual four teeth.

Length 314–360 μ; breadth at base of semicells 12–14 μ; breadth of apices 7·5–8·5 μ.

IRELAND.—Lakes, Clifden to Roundstone, Galway!

Geogr. Distribution.—United States.

6. **Pleurotænium Trabecula** (Ehrenb.) Näg.
(Pl. XXX, figs. 11–13.)

Closterium Trabecula Ehrenb. Beitr. zur Kenntniss der Organis. der Infus. 1830, p. 62 and 70; Ehrenb. Infus. 1838, p. 92, t. 6, f. II (in part; according to Turner only II 4 and II 7); Menegh. Synops. Desm. 1840, p. 235.
Pleurotænium Trabecula (Ehrenb.) Näg. Gatt. einz. Alg. 1849, p. 104, t. 6, f. A; ? Rabenh. Flor. Europ. Algar III, 1868, p. 141; Lund. Desm. Succ. 1871, p. 89; Nordst. Alg. aq. dulc. et Char. Sandvic. 1878, p. 11; ? Kirchn. Alg. Schles. 1878, p. 144; Hansg. Prodr. Algenfl. Böhm. 1888, p. 190; De Toni, Syll. Alg. 1889, p. 895; Borge, Chlor. Norska Finmark. 1892, p. 13; Nordst. Index Desm. 1896, p. 255; West & G. S. West, Desm. Singapore, 1897, p. 159; Alg. S. England, 1897, p. 483; G. S. West,

Alga-fl. Cambr. 1899, p. 113; West & G. S. West, Alga-fl. Yorks. 1900, p. 58; Freshw. Chlorophy. Koh Chang, 1901, p. 167; Alg. N. Ireland, 1902, p. 26.

Docidium Trabecula Reinsch, Algenfl. Frank. 1867, p. 183 (in part); West, Desm. Mass. 1889, p. 17, t. 2, f. 11; Turn. Freshw. Alg. E. India, 1893, p. 38; Roy & Biss. Scott. Desm. 1894, p. 242.

Cells large, subcylindrical, 11–15 times longer than their diameter; semicells with one basal inflation, rarely with a second slight undulation above it, almost cylindrical, gradually attenuated towards the apices, lateral margins almost straight, generally faintly convex; apices rounded-truncate, destitute of tubercles; cell-wall punctate.

Zygospore ellipsoid and smooth.

Length 390–664 μ; breadth at base of semicells 26–46 μ; breadth of apices 16-32 μ; length of zygosp. 70 μ, breadth 48 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W. and N. Yorks! Lancashire! Essex! Cambridge! Surrey! Hants! Devon! Cornwall!

WALES.—Capel Curig and Glyder Fawr (at 2,700 ft.), Carnarvonshire!

SCOTLAND.—Sutherland! Ross!, Inverness, Aberdeen!, Kincardine, Perth!, Arran (*Roy & Bissett*). Cumbræ, Ayr! Lewis, Outer Hebrides! Orkneys!

IRELAND.—Donegal! Galway! Kerry!

Geogr. Distribution.—France. Germany. Austria and Galicia. Italy. Norway. Sweden. Denmark. N., Central, and S. Russia. Iceland (var.). Nova Zembla. Greenland. Central China (var.). Japan (var.). India. Siam. Singapore. Abyssinia. Australia (var.). United States. Brazil. Argentina. Uruguay.

Cl. Trabecula Ehrenb. appears to have been a composite species as is amply illustrated on tab. 6 of Ehrenberg's 'Infusionsthierchen,' 1838, f. II 1–7. From these figures recent authors have selected the two (figs. II 4 and II 7) which most nearly agree with the widely distributed type of *Pleurotænium* described above.

It seems generally recognised that *Pleurotænium Trabecula* is a moderately large species, with one basal inflation to the semicells and rounded-truncate apices, which are quite destitute of tubercles.

Pl. Trabecula is a more robust species than *Pl. Ehrenbergii*, with a difference in the basal undulation of the semicells, and with smooth apices. Some of its forms approach very closely *Pl. maximum* (Reinsch) Lund.

Forma **granulata** G. S. West.

Pleurotænium Trabecula forma *granulata* G. S. West, Alga-fl. Cambr. 1899, p. 113, t. 396, f. 6.

Cell-wall distinctly and irregularly granulate.

Length 486 μ; breadth at base of semicells 35 μ; breadth of apices 25 μ.

ENGLAND.—Chippenham Fen, Cambridge!

This form is precisely analogous to *P. Ehrenbergii* var. *granulatum* Ralfs.

Forma **clavata** (Kütz.) West & G. S. West. (Pl. XXXI, figs. 8, 9.)

Docidium clavatum Kütz. in Ralfs' Brit. Desm. 1848, p. 156, t. 26, f. 3; Arch. in Pritch. Infus. 1861, p. 745, t. 2, f. 9; Cooke, Brit. Desm. 1886, p. 14, t. 6, f. 2; Roy & Biss. Scott. Desm. 1894, p. 241.

Pleurotænium clavatum (Kutz.) De Bary, Conj. 1858, p. 75; Rabenh. Flor. Europ. Alg. III, 1868, p. 141; De Toni, Syll. Alg. 1889, p. 897; West, Alg. W. Ireland, 1892, p. 119.

Docidium Trabecula f. B. *clavatum* Reinsch, Algenfl. Frank. 1867, p. 183.

Pleurotænium Trabecula forma *clavata* West & G. S. West, Alga-fl. Yorks. 1900, p. 58.

Cells about 12 times longer than their diameter; semicells slightly tumid and subclavate.

Length 300–390 μ; breadth at base of semicells 22–31 μ; maximum breadth 24–32·5 μ.

ENGLAND.—Westmoreland! (*Bissett*). W., N., and E. Yorks! Warwick (*Wills*). Sussex (*Ralfs*). Hants (*Roy*). Cornwall (*Marquand*).

WALES.—Bethesda!, Capel Curig! (*Cook & Wills*), and near Dolbadarn Castle!, Carnarvonshire. Llyn Coron, Anglesey!

SCOTLAND.—Sutherland, Ross, Inverness, Nairn, Aberdeen, Kincardine, Forfar, Perth! (*Roy & Bissett*). Kirkcudbright!

IRELAND.—Galway! Dublin and Wicklow (*Archer*). Antrim!

Geogr. Distribution.—France. Germany. Italy. Sweden. United States.

Var. **rectum** (Delp.) *nob.* (Pl. XXX, figs. 9, 10.)

Pleurotænium rectum Delp. Desm. Subalp. 1877, p. 129, t. 20, f. 8–11; De Toni, Syll. Alg. 1889, p. 896; West, Alg. W. Ireland, 1892, p. 120; Lütkem. Desm. Attersees, 1893, p. 546; Roy & Biss. Scott. Desm. 1894, p. 242; Nordst. Index Desm. 1896, p. 222.
Penium rectum (Delp.) Wille, Sydamerik. Algfl. 1884, p. 22.
Docidium rectum (Delp.) Wolle, in Bull. Torr. Bot. Club, 1885, p. 2.
Pleurotænium maximum West, Alg. W. Ireland, 1892, p. 119.
Pl. maximum var. *occidentale* West, Alg. Eng. Lake Distr. 1892, p. 719.

Cells rather smaller than in the type, straight, 12–18 times longer than their diameter; lateral margins of semicells above the slight basal inflation straight; cell-wall often smooth.

Length 212–408 μ; breadth at base of semicells 22–23 μ; breadth of apices 14–20 μ.

ENGLAND.—Enbridge Lake, Hants. (*Roy*).

WALES.—Capel Curig, Carnarvonshire (*Roy*).

SCOTLAND.—General (*Roy & Bissett*). We have only found it in Aberdeen, Ross, Inverness, Sutherland, and the Outer Hebrides!

IRELAND.—Cromagloun, Kerry!

Geogr. Distribution.—Italy. Austria. Hungary. Galicia. Norway. Sweden. Central China. India. New Zealand (var.). Australia. United States. Brazil.

It is impossible to retain *Pleurotænium rectum* Delp. as a species separate from *Pl. Trabecula* (Ehrenb.) Näg. It only differs in the somewhat smaller size of the cells and the straighter lateral margins of the semicells. It is frequent in some districts of Scotland and Ireland, but is very uncommon in England.

Var. **rectissimum** *var. nov.* (Pl. XXX, figs. 14, 15.)

Cells more elongate than in the type, 26–30 times longer than their diameter, rigidly straight; semicells with the slight basal undulation of the type, very gradually attenuated to the apices, which are dilated and rounded-truncate.

Length 544–628 μ; breadth at base of semicells 23–23·5 μ; breadth of apices 14 μ.

SCOTLAND.—Rhiconich, Sutherland !

7. **Pleurotænium maximum** (Reinsch) Lund.

(Pl. XXXI, figs. 1, 2.)

Docidium maximum Reinsch, Spec. Gen. Alg. 1867, p. 140, t. 20 C II, f. 1, 2; Algenfl. Franken, 1867, p. 184, t. 12, f. 4; Roy & Biss. Scott. Desm. 1894, p. 241.

Pleurotænium maximum (Reinsch) Lund. Desm. Suec. 1871, p. 89; De Toni, Syll. Alg. 1889, p. 899; Nordst. Index Desm. 1896, p. 166; West & G. S. West, Welw. Afric. Freshw. Alg. 1897, p. 80; Freshw. Chlorophy. Koh Chang, 1901, p. 167; Freshw. Alg. Ceylon, 1902, p. 145.

Pleurotænium Archerii Delp. Desm. Subalp. 1877, p. 128, t. 19, f. 12–16; Wille, Sydamerik. Algfl. 1884, p. 23; De Toni, Syll. Alg. 1889, p. 902; Lütkem. Desm. Attersees, 1893, p. 546.

Docidium Archerii (Delp.) Wolle, in Bull. Torr. Bot. Club. 1885, p. 2.

Cells large, subcylindrical and elongated, 14–18 times longer than their diameter; semicells with a prominent basal inflation and often with a smaller undulation immediately above it, very slightly tumid and then gradually tapering to the apices, which are truncate with rounded angles; cell-wall punctate.

Zygospore unknown.

Length 568–852 μ; breadth at base of semicells 38–54 μ; breadth in middle of semicells 31–42 μ; breadth of apices 22–30 μ.

WALES.—Capel Curig, Carnarvonshire !

SCOTLAND.—Scolty, near Banchory, Kincardine (*Roy & Bissett*). Aberdeen !

Geogr. Distribution.—France. Germany. Italy. Austria and Galicia. Hungary. Sweden. Japan (var.). Ceylon. Siam. Abyssinia. W. Africa. Brazil. Ecuador (var.). Paraguay. Uruguay.

This species differs very little from *Pl. Trabecula*, being distinguished by its larger size and the greater prominence of the basal inflation of the semicells. It is one of the largest and likewise one of the rarest Desmids which occur in the British Islands.

8. **Pleurotænium Hutchinsonii** (Turn.) West & G. S. West.

(Pl. XXXI, fig. 7.)

Docidium Hutchinsonii Turn. Desm. Notes, 1893, p. 346, fig. 16.
Pleurotænium Hutchinsonii (Turn.) West & G. S. West, Alga-fl. Yorks. 1900, p. 59.

Cells somewhat small, 11–12 times longer than their diameter; semicells with a slight basal inflation, very slightly attenuated to the apices; lateral margins faintly sinuate, apices truncate with broadly rounded angles; cell-wall covered with small papillæ (2·5–3 μ in length; those at the apices 1·7–2 μ in length).

Zygospore unknown.

Length 245–280 μ; breadth at base of semicells 21–26 μ; breadth of apices 17–19·5 μ.

ENGLAND.—Strensall Common, N. Yorks. (*W. B. Turner*).

9. **Pleurotænium nodosum** (Bail.) Lund.

(Pl. XXXI, figs. 3–6.)

Closterium nodosum Bailey, 1846.
Docidium nodosum Bail. in Ralfs' Brit. Desm. 1848, p. 218, t. 35, f. 8; Bail. Microscop. observ. 1851, t. 1, f. 4; Arch. in Pritch. Infus. 1861, p. 745; Rabenh. Flor. Europ. Algar. III, 1868, p. 145; Arch. in Quart. Journ. Micr. Sci. 1872, p. 193 ("forma"); Wolle, Desm. U.S. 1884, p. 50, t. 11, f. 11, 12; t. 12, f. 20; Cooke, Brit. Desm. 1886, p. 12, t. 7, f. 2; Borge, Austral. Süsswasserchlor. 1896, p. 27, t. 4, f. 49–51.
Pleurotænium nodosum (Bail.) Lund. Desm. Suec. 1871, p. 90; Nordst. Alg. Brasil. 1877, p. 17; Freshw. Alg. N. Zeal. 1888, p. 65; Johnson, Rare Desm. U.S. II, 1894, p. 290; West & G. S. West, Some N. Amer. Desm. 1896, p. 234; Some Desm. U.S. 1898, p. 285; Freshw. Alg. Ceylon, 1902, p. 141.
Docidium nodosum var. *Hibernicum* Cooke, Brit. Desm. 1886, p. 13.
Docidiopsis nodosa Raeib. Desm. Nowe, 1889, p. 107, t. 7, f. 22.
D. nodosum α. typica Turn. Freshw. Alg. E. India, 1893, p. 35.
D. nodosum γ. dentatum Turn. l. c.

Cells large or moderately large, $6\frac{1}{2}$–8 times longer than their diameter; semicells with nodulose margins, caused by four rings of prominent nodules, one basal ring, and three other equidistant rings, 6–8 nodules in each ring, gradually tapering from base to apex; apices dilated, convexo-truncate, furnished with a peripheral ring of 6–8 conical teeth (which do not project beyond the extreme apex); cell-wall smooth or distinctly punctate.

Zygospore unknown.

Length 280–520 μ; maximum breadth 40–80 μ; breadth of apices 24–50 μ.

WALES.—Capel Curig, Carnarvonshire! (*Cooke & Wills*).

SCOTLAND.—Rhiconich and Lower Duartmore, Sutherland!

IRELAND.—Connemara, Galway (*Archer*).

Geogr. Distribution.—Germany. Galicia in Austria. Norway. Sweden. India. Ceylon. Singapore. Java. New Zealand. United States. Brazil.

This is one of the most handsome of the British species of *Pleurotænia,* and it is also one of the rarest, being confined to certain of the rocky districts of the west coast. It is a somewhat variable species, especially in the relative prominence of the rings of nodules, in the shape of the nodules themselves, and in the width and degree of extension of the apex. The apical teeth were not illustrated by Bailey (in Ralfs' Brit. Desm. t. 35, f. 8), but that was purely an oversight. They are present in all specimens of *Pl. nodosum,* both American, European, Asiatic, and Australasian. We were at first inclined to believe that all the British examples were of comparatively small size, but we have since obtained Scottish specimens equal in size to the largest American or Asiatic forms.

There is no excuse for the names "*a. typica*" and "*γ. dentata*" given by Turner to forms of this species. If Turner had examined a sufficient number of specimens from different localities, he would have found that all were dentate at the apex, and that the species was not exceptional in the matter of variation within certain limits.

Turner also describes "*β. anglicum*" from Capel Curig, N. Wales (*Wills*), and from near Windermere (*Turner*); *vide* 'Freshw. Alg. E. India,' 1893, p. 35. He says that near the apex are 10–12 small nodes or hollow tubercles, but his figure gives one the impression that the apex was in an oblique position when sketched. We have examined a number of specimens of this Desmid from Capel Curig, collected over a period of nine years, and have always found the apices typical.

Genus 12. **Tetmemorus** Ralfs, 1844.

Ralfs' in Ann. Mag. Nat. Hist. 1844, p. 256.
Hassall, Brit. Freshw. Alg. 1845, p. 377.
Ralfs, Brit. Desm. 1848, p. 145.
Arch. in Pritch. Infus. 1861, p. 720 and 746.
Rabenh. Flor. Europ. Algar. III, 1868, p. 139.
Cooke, Brit. Desm. 1886, p. 48.
De Toni, Syll. Alg. 1889, p. 866.

Cells elongated, straight, cylindrical or fusiform-cylindrical, a little compressed at each apex, slightly constricted in the middle, with a very narrow incision in the middle of each apex, apical angles rounded; vertical view circular or broadly elliptical; cell-wall minutely scrobiculate, or punctate; with a single chloroplast in each semicell, containing a central row of pyrenoids.

This genus is easily distinguished from *Pleurotænium* by the well-marked apical incisions, and by other minor characters. It differs from *Closterium* in its straight cells, its median constriction, and in its broad apices with median incisions. From *Penium* it is distinguished by its more evident median constriction and its apical incisions; from some *Penia* it is also at once separated by its method of division and the absence of periodical growth.

It is closely connected with *Euastrum* through the American Desmid *Euastrum giganteum* (Wood) Nordst., formerly described by Wood as *Tetmemorus giganteus*.

The nearest genus to it in the general form of the cells is the African and S. American genus *Ichthyocercus*.

1. **Tetmemorus Brébissonii** (Menegh.) Ralfs.

(Pl. XXXII, figs. 1, 2.)

Closterium Brebissonii Menegh. Synops. Desm. 1840, p. 236.

Tetmemorus Brebissonii (Menegh.) Ralfs, in Ann. Mag. Nat. Hist. 1844, p. 257, t. 8, f. 1; Hass. Brit. Freshw. Alg. 1845, p. 377, t. 89, f. 5; Ralfs, Brit. Desm. 1848, p. 145, t. 24, f. 1 *a*, *b*, *c*; De Bary, Conj. 1858, p. 73; Arch. in Pritch. Infus. 1861, p. 746, t. 2, f. 11–13; Rabenh. Flor. Europ. Algar. III, 1868, p. 139; Kirchn. Alg. Schles. 1878, p. 145; Wolle, Desm. U.S. 1884, p. 91, t. 20, f. 1, 2; t. 50, f. 36; Cooke, Brit. Desm. 1886, p. 48, t. 18, f. 7; Hansg. Prodr. Algenfl. Böhm. 1888, p. 188; De Toni, Syll. Alg. 1889, p. 866; West, Alg. W. Ireland, 1892, p. 131; Roy & Biss. Scott. Desm. 1894, p. 242; Nordst. Index Desm. 1896, p. 68; West & G. S. West, Alg. S. England, 1897, p. 483; Alga-fl. Yorks. 1900, p. 59; Alg. N. Ireland, 1902, p. 26.

Penium (Tetmemorus) Brébissonii Kütz. Spec. Alg. 1849, p. 167 (in part).
? *Tetmemorus penioides* Benn. Freshw. Alg. Eng. Lake Distr. 1886, p. 13, t. 2, f. 26; Cooke, Brit. Desm. 1886, p. 50, t. 19, f. 9; t. 26, f. 2; De Toni, Syll. Alg. 1889, p. 869.

Cells subcylindrical, 4–6 (commonly 5) times longer than their diameter, with a conspicuous median constriction; semicells very slightly attenuated from base to apex; apices very broadly rounded, with a deep median incision; cell-wall minutely scrobiculate or punctulate, punctulations arranged in distinct longitudinal lines; chloroplasts with a single median series of four or five pyrenoids; cells in side view more fusiform, semicells attenuated.

Zygospore globose, with a thick smooth cell-wall.

Length 155–220 μ; breadth 30–41 μ; breadth of isthmus 22–32 μ; diam. zygosp. 80 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). W. and N. Yorks! Lancashire! Leicester (*Roy*). Warwick (*Wills*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Kent (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*).

WALES.—General! (At 2,200 ft. on Glyder Fach, and 2,700 ft. on Glyder Fawr, Carnarvonshire.)

SCOTLAND.—General! (*Roy & Bissett*). Outer Hebrides! Orkneys!

IRELAND.—Donegal! Mayo! Galway! Kerry! Dublin and Wicklow (*Archer*). Down! Londonderry!

Geogr. Distribution.—France. Belgium. Germany. Austria and Galicia. Italy. Norway. Sweden. Denmark. N. Russia. India. Australia (var.). New Zealand. Azores. United States. Brazil. Guiana.

This species is by no means common, and we never find it in any quantity except in permanent bogs and at the margins of lakes. It would appear that British specimens are larger than those found in many parts of continental Europe. Ralfs' measurements of his typical form were: length 215 μ, breadth 36 μ, agreeing very well with our own measurements; whereas many continental observers give dimensions not much more than half as large (length 78–116 μ; breadth 19–21 μ).

It is difficult to correctly place the form described by

Bennett as *T. penioides*, but allowing sufficient latitude for Bennett's inaccurate drawings and observations, we have little hesitation in placing it under *T. Brébissonii*.

Var. **turgidus** Ralfs. (Pl. XXXII, fig. 3.)

Tetmemorus Brébissonii var. *turgidus* Ralfs, Brit. Desm. 1848, p. 145, t. 24, f. 1 *d*, *e*; Cooke, Brit. Desm. 1886, p. 49; West, Alg. N. Wales, 1890, p. 286; Roy & Biss. Scott. Desm. 1894, p. 242.

Cells more deeply constricted; semicells inflated.

Length 155 μ; breadth (maximum) 43–44 μ; breadth of isthmus 26 μ.

ENGLAND.—Ashdown Forest, Sussex (*Ralfs*).

WALES.—Snowdon, Carnarvonshire!

SCOTLAND.—Not uncommon (*Roy & Bissett*). Perth!

Geogr. Distribution.—Poland. Australia. United States.

Var. **attenuatus** Nordst.

Tetmemorus Brébissonii var. *attenuatus* Nordst. in Botan. Notis. 1887, p. 163; Freshw. Alg. N. Zeal. 1888, p. 66, t. 3, f. 18.

Semicells more or less sensibly attenuated towards the apices.

Length 134–192 μ; breadth 27–30 μ; breadth of isthmus 24 μ.

SCOTLAND.—Ben Laoigh, Perth!

Geogr. Distribution.—New Zealand.

Var. **minor** De Bary. (Pl. XXXII, figs. 4, 5.)

Tetmemorus Brébissonii var. *minor* De Bary, Conj. 1858, p. 73, t. 5, f. 9 (Ralfs, l. c. f. 1 *f*); Rabenh. Flor. Europ. Algar. III, 1868, p. 140; Roy & Biss. Scott. Desm. 1894, p. 242.

Cells not more than half the size of the type; semicells broadest towards the apices, lateral margins towards the base gently hollowed.

Length 64–82 μ; breadth (maximum) 17·5–20 μ; breadth of isthmus 14·5–15 μ.

ENGLAND.—Brandreth, Cumberland! Hawkshead, Lancashire!

Wales.—Llyn Bochlwyd and Twll Dhu, Carnarvonshire!

Scotland.—Common! (*Roy & Bissett*). Common in Outer Hebrides! Orkneys!

Ireland.—Galway! Kerry!

Geogr. Distribution.—Germany. Poland. Norway. Sweden. Denmark.

This variety is strikingly abundant in the west and north-west of Scotland. The form of the cells, which are broadest towards the apices, is very characteristic.

Var. **minimum** *nob.* (Pl. XXXII, fig. 6.)

Tetmemorus Brébissonii var. *minor* West, Alg. W. Ireland, 1892, p. 132 (in part).

Cells very small; lateral margins of semicells parallel.

Length 57 μ; breadth 15 μ; breadth of isthmus 11 μ.

Ireland.—Near Oughterard, Galway!

2. **Tetmemorus granulatus** (Bréb.) Ralfs.

(Pl. XXXII, figs. 7–9.)

Closterium granulatus Bréb. in Cheval. microscop. et usage, Paris, 1839, p. 272; Bréb. in Menegh. Synops. Desm. 1840, p. 236.

Tetmemorus granulatus Ralfs, in Ann. Mag. Nat. Hist. 1844, p. 257, t. 8, f. 2; Hass. Brit. Freshw. Alg. 1845, p. 378, t. 89, f. 6; Ralfs, Brit. Desm. 1848, p. 147, t. 24, f. 2; t. 33, f. 1; De Bary, Conj. 1858, p. 29, etc., t. 5, f. 11; Arch. in Pritch. Infus. 1861, p. 746; Rabenh. Flor. Europ. Algar. III, 1868, p. 140, f. 55; Kirchn. Alg. Schles. 1878, p. 145; Cooke, Brit. Desm. 1886, p. 49, t. 18, f. 8; t. 19, f. 1; Hansg. Prodr. Algenfl. Böhm. 1888, p. 189; De Toni, Syll. Alg. 1889, p. 867; West, Alg. N. Yorks. 1889, t. 291, f. 5; West, Alg. W. Ireland, 1892, p. 132; Roy & Biss. Scott. Desm. 1894, p. 242; Nordst. Index Desm. 1896, p. 135; West & G. S. West, Alg. S. England, 1897, p. 483; Alga-fl. Yorks. 1900, p. 59; Alg. N. Ireland, 1902, p. 26.

Penium (Tetmemorus) granulatus Kütz. Spec. Alg. 1849, p. 167.

Cells fusiform in both front and side views, 5–5½ times longer than their diameter, with a slight median constriction; semicells gradually attenuated from the base to the apex; apices rounded, with a median incision of somewhat variable depth, apical angles rounded or subacute; cell-wall finely scrobiculate, those scrobiculations near the isthmus being disposed in horizontal lines, the rest scattered; chloroplasts with a median series of four or five pyrenoids; semicells in side view rather suddenly narrowed near the apex.

Zygospore globose, with a thick, smooth cell-wall.

Length 138–239 μ; breadth 30–45 μ; breadth of isthmus 25–40 μ; diam. zygosp. 63–73 μ.

ENGLAND.—Cumberland! Westmoreland! (*Ralfs*). Lancashire! (*Ralfs*). W., N., and E. Yorks! Cheshire (*Roy*). Leicester (*Roy*). Essex! Warwick (*Wills*). Gloucester (*Ralfs*). Surrey! (*Ralfs*). Sussex (*Ralfs*). Kent! (*Ralfs*). Hants! (*Ralfs*). Devon! Cornwall! (*Ralfs*); zygosp. from Tintagel!

WALES.—Common!; at 2,200 ft. on Glyder Fach, and at 2,700 ft. on Glyder Fawr, Carnarvonshire.

SCOTLAND.—Abundant! (*Roy & Bissett*); zygospores from Fyvie and Birsemore, Aberdeen; Glen Dye, Kincardine. Up to 3,500 ft. on Lochnagar! Outer Hebrides! Orkneys! Shetlands!

IRELAND.—Abundant (zygosp. from Lough Anna, Donegal)!

Geogr. Distribution.—France. Belgium. Germany. Austria and Galicia. Hungary. Italy. Portugal. Norway. Sweden. Denmark. Bornholm. N. and S. Russia. Iceland. Greenland. China. Ceylon. Java. Australia. Sandwich Islands. Azores. United States. W. Indies.

T. granulatus is the most abundant and generally distributed species of *Tetmemorus*. It is a very cosmopolitan species and occurs from sea-level to the snow-line, but rarely in the freshwater plankton. In *Sphagnum*-bogs it sometimes occurs in large quantities, and almost pure gatherings of it can be obtained. It is a more slender and more attenuated species than *T. Brébissonii*, with a less conspicuous difference between the front and side views, and a different arrangement of the marks on the cell-wall. The specific name "*granulatus*" is somewhat unfortunate, as the cell-wall is not granulate but finely scrobiculate, the scrobiculations being the optical expression of pores through the cell-wall.

Abnormalities of this Desmid are sometimes met with, one of the most curious and interesting being a form in which one semicell is bifurcated at the apex. *Vide* Jacobs. Desm. Danem. 1875, t. 8, f. 31; West and G. S. West, Obs. on Conj. 1898, t. 4, f. 40. Another abnormal cell has been observed which consisted of three "semicells"; West, Alg. N. Yorks. 1889, t. 291, f. 5.

Forma **minor** Nordst.

Tetmemorus granulatus forma *minor* Nordst. Alg. aq. dulc. et Char. Sandvic. 1878, p. 10; West, Alg. W. Ireland, 1892, p. 132; West & G. S. West, Alga-fl. Yorks. 1900, p. 60; Alg. N. Ireland, 1902, p. 27.

Cells considerably smaller than the average size.

Length 95–117 μ; breadth 21–28 μ.

ENGLAND.—Near Settle, Great Sleddale, and bog near Widdale Beck, Yorks!

SCOTLAND.—Near Scourie, Sutherland!

IRELAND.—Near Glenties, Donegal! Ballynahinch, Galway!

Geogr. Distribution.—New Zealand. Sandwich Islands.

Var. **attenuatus** West. (Pl. XXXII, fig. 10.)

Tetmemorus granulatus var. *attenuatus* West, Alg. W. Ireland, 1892, p. 132, t. 20, f. 7; West & G. S. West, Some N. Amer. Desm. 1896, p. 238; Alg. N. Ireland, 1902, p. 27.

Semicells rather suddenly but slightly attenuated just below the apices.

Length 170–182 μ; greatest breadth 30 μ; breadth of isthmus 22–25 μ; breadth of apex 15–17 μ; breadth below apex 15 μ.

ENGLAND.—Blea Tarn and Stickle Tarn, Westmoreland! Hawkshead, Lancashire!

WALES.—Bog below Llyn Idwal, Carnarvonshire!

SCOTLAND.—Loch Luichart, Ross! Loch Macaterick, Ayr! Hoy and Kirkwall, Orkneys! Scalloway and Lerwick, Shetlands!

IRELAND.—Donegal! Galway! Kerry!

Geogr. Distribution.—United States.

We have examined American specimens of this variety up to 303 μ in length.

3. **Tetmemorus lævis** (Kütz.) Ralfs.

(Pl. XXXII, figs. 11–16.)

Closterium læve Kütz. Phycolog. germ. 1845, p. 132.
Tetmemorus lævis (Kütz.) Ralfs, Brit. Desm. 1848, p. 146, t. 24, f. 3; Arch. in Pritch. Infus. 1861, p. 746; Rabenh. Flor. Europ. Algar. III, 1868, p. 140; Kirchn. Alg. Schles. 1878, p. 145; Wolle, Desm. U.S. 1884, p. 91, t. 20, f. 3; t. 50, f. 35; Cooke, Brit. Desm. 1886, p. 49, t. 19, f. 2; Hansg. Prodr. Algenfl. Böhm. 1888, p. 188; De Toni, Syll. Alg. 1889, p. 868; West, Alg. W. Ireland, 1892, p. 132; Roy & Biss. Scott. Desm. 1894, p. 242; Nordst. Index Desm. 1896, p. 153; West & G. S. West, Alg. S. England, 1897, p. 483; Alga-fl. Yorks. 1900, p. 60; Alg. N. Ireland, 1902, p. 27.
Penium (Tetmemorus) læve Gay, Monogr. loc. Conj. 1884, p. 71.

Cells small, $3\frac{1}{2}$–$4\frac{1}{2}$ (commonly 4) times longer than their diameter, with a slight median constriction; semicells very gradually attenuated to the apices; apex fairly broad and rounded, with a deep median incision; cell-wall minutely punctate; chloroplasts with a median series of 3–5 pyrenoids; semicells in side view more attenuated than in front view, especially near the apex.

Zygospore ovoid, compressed, enclosed within an outer, compressed, quadrate coat.

Length 67·5–123 μ; breadth 20–31·5 μ; breadth of isthmus 16–27 μ; length of zygosp. 57 μ.

ENGLAND.—Cumberland! Westmoreland! (*Bissett*). W., N., and E. Yorks! Lancashire! Leicester (*Roy*). Essex! Norfolk (*Cooke*). Warwick (*Wills*). Surrey! Sussex (*Ralfs*). Hants! (*Bennett*). Kent! Devon! Cornwall (*Marquand*).

WALES.—General and abundant!; at 2,200 ft. on Glyder Fach, Carnarvonshire.

SCOTLAND.—General! Zygosp. from Whitestripes Moss and Aboyne, Aberdeen; Cammie in Strachan, Kincardine (*Roy & Bissett*). At 3,500 ft. on Lochnagar! Outer Hebrides! Orkneys! Shetlands!

IRELAND.—General, but not common!

Geogr. Distribution.—France. Belgium. Germany. Austria and Galicia. Italy. Norway. Sweden. Denmark. Bornholm. N. and S. Russia. Nova Zembla. Greenland. Singapore. Australia. New Zealand.

Sandwich Islands (var.). Azores. United States. Dominica and Trinidad, W. Indies. Brazil.

This small species of the genus is almost as generally distributed as *T. granulatus*, and at high elevations is often much more abundant. The median constriction is often very faint, and the semicells are not so attenuated as those of *T. granulatus*; the zygospore is also peculiar. The cell-wall is always minutely punctate, sometimes more distinctly than at others.

T. lævis has a world-wide distribution; it is found from sea-level to the snow-line, and also in the waters of warm and hot springs. It is rarely found in the freshwater plankton.

4. **Tetmemorus minutus** De Bary.

(Pl. XXXII, figs. 17–19.)

Tetmemorus minutus De Bary, Conj. 1858, p. 41, 74, t. 5, f. 10; Arch. in Pritch. Infus. 1861, p. 746; Rabenh. Flor. Europ. Algar. III, 1868, p. 140; Kirchn. Alg. Schles. 1878, p. 145; Hansg. Prodr. Algenfl. Böhm. 1888, p. 189; De Toni, Syll. Alg. 1889, p. 868; Benn. Freshw. Alg. S.W. Surrey, 1892, p. 5; Roy & Biss. Scott. Desm. 1894, p. 242; Nordst. Index Desm. 1896, p. 172; West & G. S. West, Alga-fl. Yorks. 1900, p. 60.

Cells small, about 3 times longer than their diameter, with a slight median constriction; semicells conspicuously attenuated from base to apex; apices with a deep median incision; cell-wall delicately and somewhat sparsely punctate; chloroplasts with one or two pyrenoids; semicells in the side view rather more attenuated than in the front view.

Zygospore unknown.

Length 52–65 μ; breadth 19–21 μ; breadth of isthmus 18·5 μ.

England.—Dodd Fell, N. Yorks. (at 2,000 ft.)! Hindhead, Surrey (*Bennett*).

Wales.—Capel Curig (*Roy*), Pen-y-gwryd (*Roy*), and Llyn Bochlwyd!, Carnarvonshire. Radnorshire!

Scotland.—Not uncommon on wet rocks (*Roy & Bissett*). Moidart, Inverness! General throughout the Outer Hebrides!

Ireland.—Dublin and Wicklow (*Archer*).

Geogr. Distribution.—Germany. Galicia in Austria. Norway. Sweden. Azores. United States (?). Brazil.

This is the smallest and rarest species of the genus. It is somewhat smaller than the average forms of *T. lævis,* and the semicells are more attenuated. The cell-wall is not smooth as described by De Bary, but is punctate as in all other species of the genus, the punctulations being very delicate and not easily seen. Roy records it from Scotland as "not uncommon on wet rocks," but we find *T. lævis* more usual in such situations. *T. minutus* is frequent in the bog-pools in the Outer Hebrides.

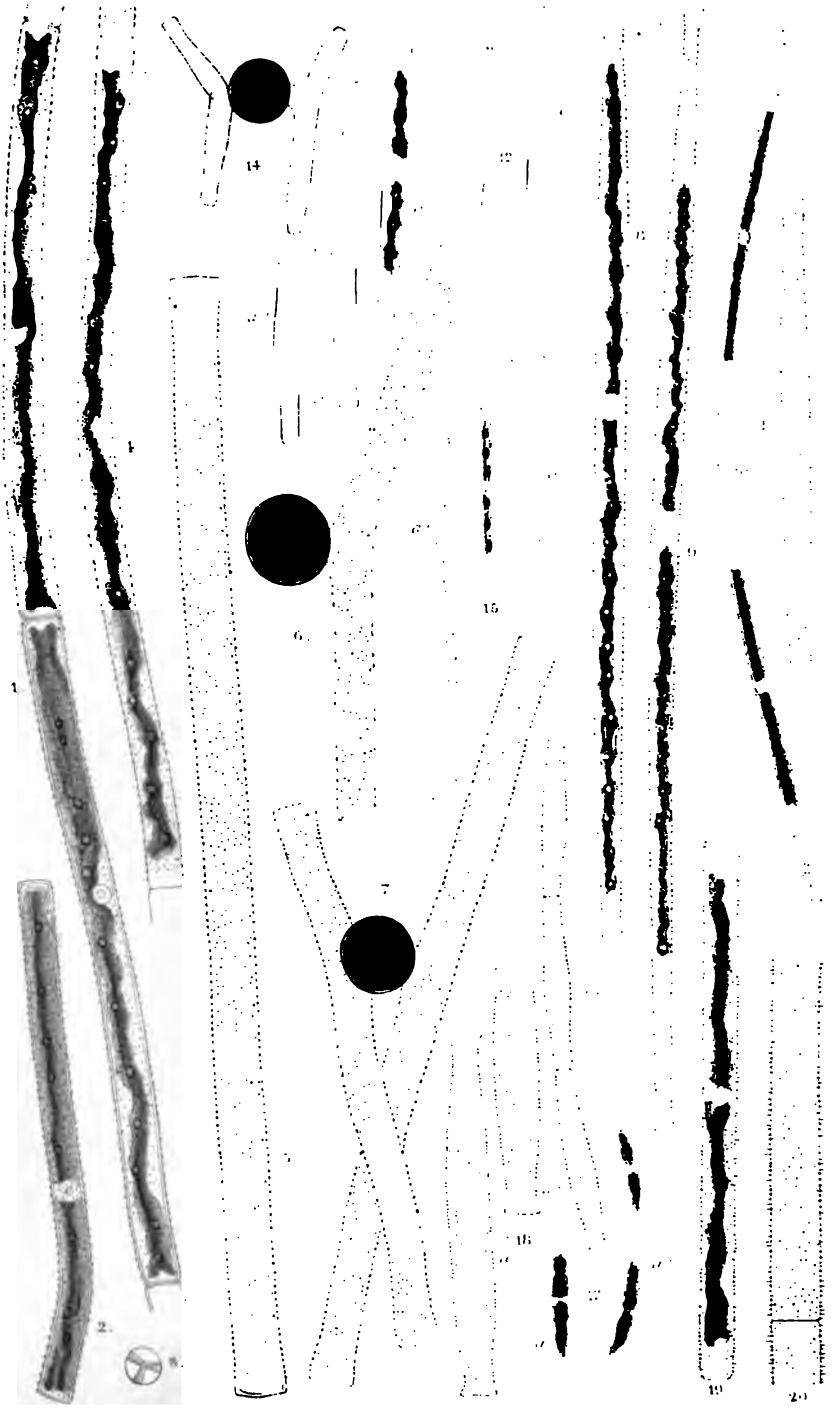
All Wolle's figures of the genus *Tetmemorus* are very bad ones. The zygospores figured by him (Desm. U.S. 1884, t. 20, figs. 7–9) do not belong to *T. minutus*, but to *T. lævis.*

Plate 1

PLATE I.

FIGS.		PAGE
1–7.—	*Gonatozygon monotænium* De Bary. 1–3, 6, after De Bary, × 390; 4, 5, 7, × 520; 6 and 7, zygospores	30
8–11.—	*G. Brébissonii* De Bary. 8, 9, 11, × 520; 10, after De Bary, × 390	31
12–14.—	*G. Brébissonii* var. *læve* (Hilse) West & G. S. West. 12 and 13, × 400; 14, zygospore, after De Bary, × 390	32
15.—	*G. Brébissonii* var. *minutum* West & G. S. West. × 400	33
16.—	*G. Brébissonii* var. *minutum* West & G. S. West, forma. × 400	33
17.—	*G. Kjellmani* Wille. After Wille, × 400	33
18.—	*G. Kjellmani* forma *minor* West & G. S. West. × 830	34
19–20.—	*G. pilosum* Wolle. 19, × 400; 20, after Wolle, × 500	34

PLATE I



del.

Plate 2

PLATE II.

FIGS.		PAGE
1–3.—	*Gonatozygon Kinahani* (Arch.) Rabenh. 1 and 2, × 400; 3, × 520	35
4–6.—	*Genicularia spirotænia* De Bary. After De Bary, × 390	36
7–10.—	*Spirotænia condensata* Bréb. 7, after De Bary, × 390; 8, × 520; 9 and 10, zygospores, after Archer, × 300	38
11.—	*Sp. turfosa* West & G. S. West. × 520	42
12–14.—	*Sp. fusiformis* West & G. S. West. × 520	43
15–18.—	*Sp. parvula* Arch. After Archer, × 400	43
19.—	*Sp. closteridia* (Bréb.) Arch. After Kützing, × 600	39
20–23.—	*Sp. endospira* (Kütz.) Arch. After De Bary, 20, × 390; 21–23, × 750	39
24–26.—	*Sp. truncata* Arch. After Archer, × 400; 26, zygospore	40

PLATE II

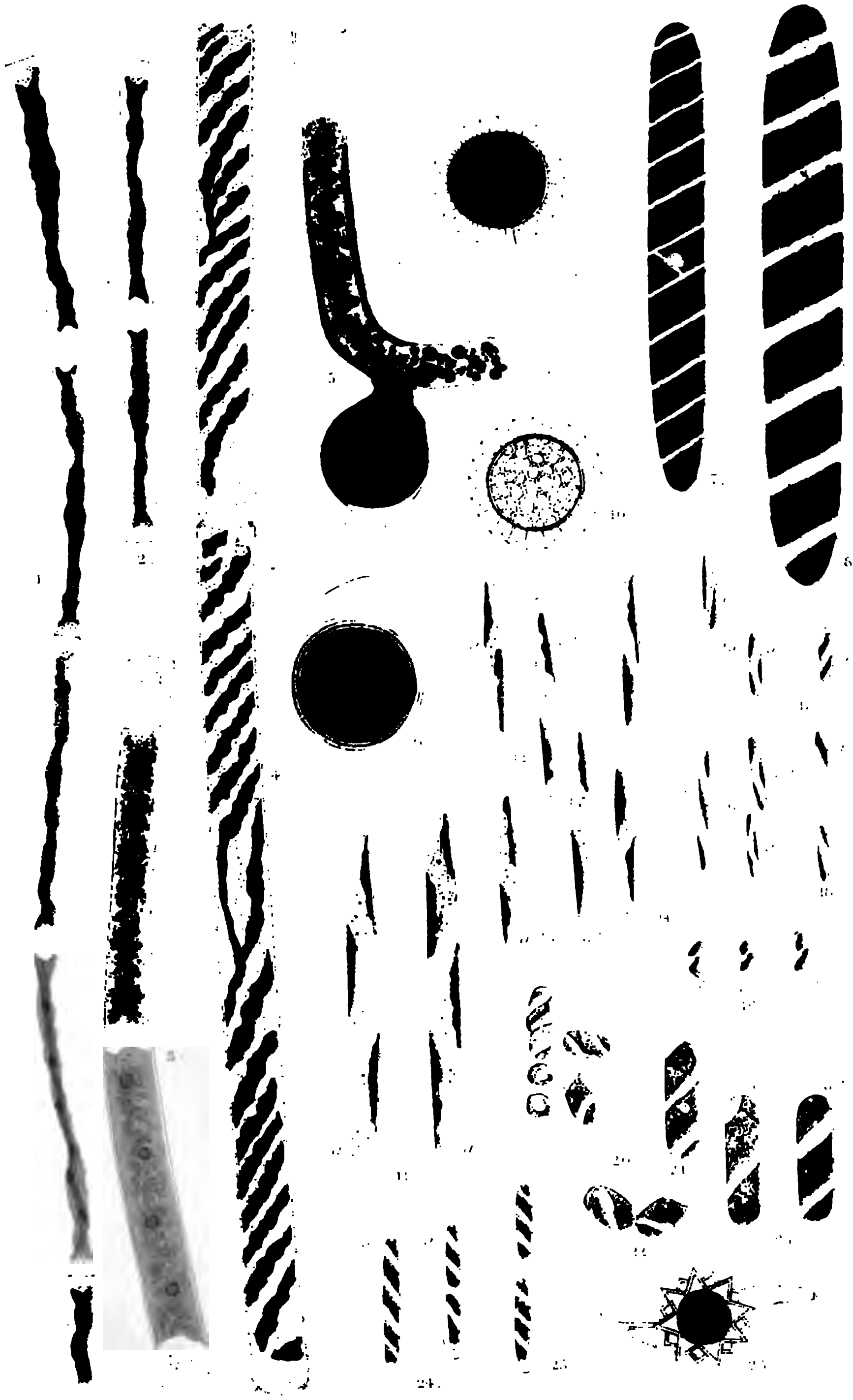


Plate 3

PLATE III.

FIGS.		PAGE
1–3.	—*Spirotænia minuta* Thur. 1 and 2, × 520; 3, after Lütkemüller, × 500	41
4–6.	—*Sp. eboracensis* G. S. West. × 520	42
7–12.	—*Sp. obscura* Ralfs. 7–11, after Lütkemüller, × 500; 12, × 400	44
13.	—*Sp. bispiralis* West. × 400	45
14–15.	—*Sp. acuta* Hilse. × 520	46
16–17.	—? *Sp. tenerrima* Arch. × 520	47
18–19.	—*Mesotænium De Greyi* Turn. After Turner, × 500	49
20.	—*M. De Greyi* var. *breve* West. × 400	50
21.	—*M. De Greyi* forma *major* West and G. S. West. × 400	49
22.	—*M. De Greyi* forma *tenuis* West & G. S. West. × 520	50
23–24.	—*M. Kramstai* Lemm. 23, × 520; 24, after Lemmermann, × 305	57
25–26.	—*M. purpureum* West & G. S. West. × 520	55
27–33.	—*M. violascens* De Bary. After De Bary, × 390	55
34–36.	—*M. macrococcum* (Kutz.) Roy & Biss. After De Bary, × 390	51

PLATE III.

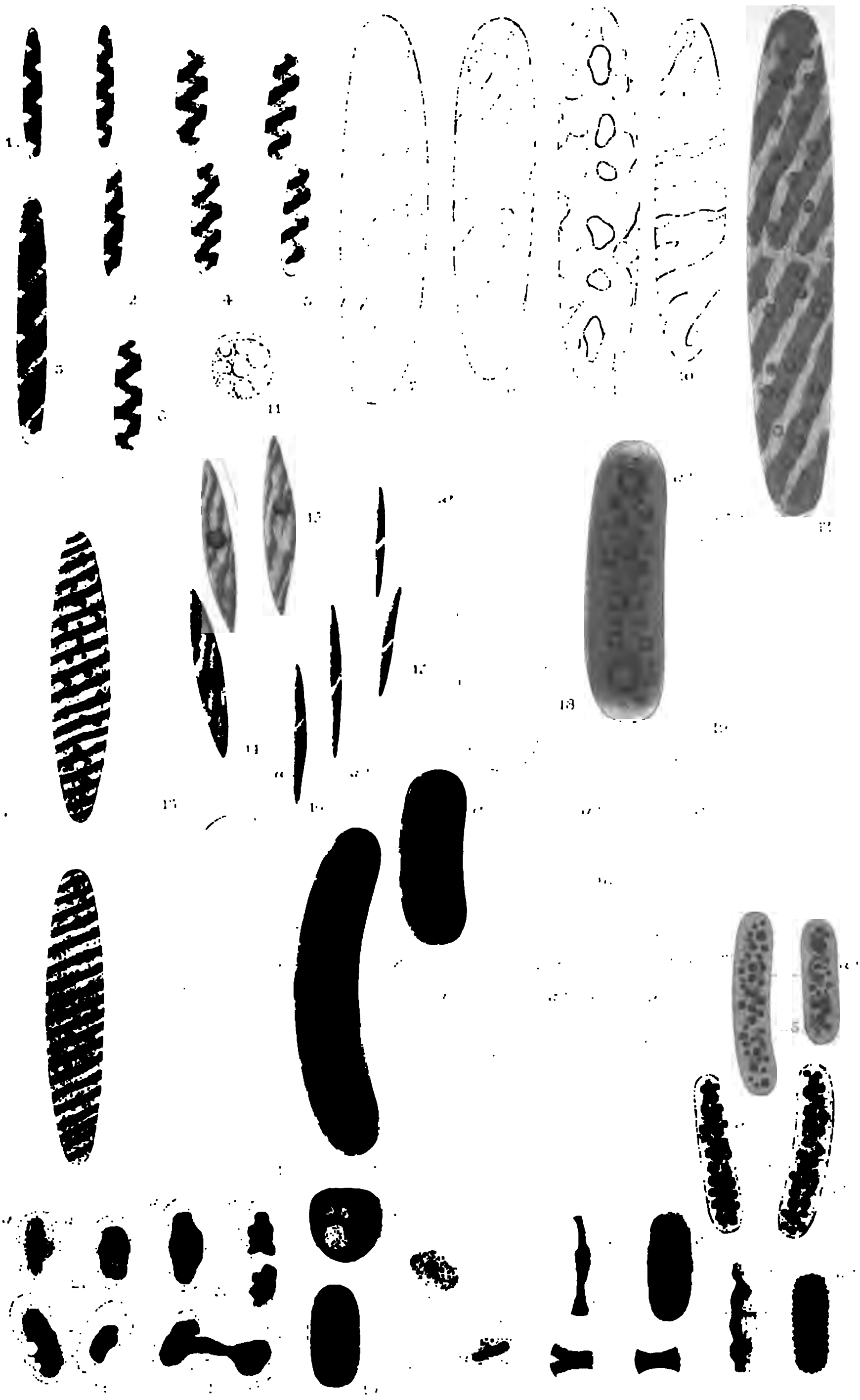


PLATE I.

FIGS.		PAGE
1–7.—	*Gonatozygon monotænium* De Bary. 1–3, 6, after De Bary, × 390; 4, 5, 7, × 520; 6 and 7, zygospores	30
8–11.—	*G. Brébissonii* De Bary. 8, 9, 11, × 520; 10, after De Bary, × 390 . . .	31
12–14.—	*G. Brébissonii* var. *læve* (Hilse) West & G. S. West. 12 and 13, × 400; 14, zygospore, after De Bary, × 390 . . .	32
15.—	*G. Brébissonii* var. *minutum* West & G. S. West. × 400	33
16.—	*G. Brébissonii* var. *minutum* West & G. S. West, forma. × 400 . . .	33
17.—	*G. Kjellmani* Wille. After Wille, × 400 .	33
18.—	*G. Kjellmani* forma *minor* West & G. S. West. × 830	34
19–20.—	*G. pilosum* Wolle. 19, × 400; 20, after Wolle, × 500	34

Plate 4

PLATE IV.

FIGS.		PAGE
1–3.—	*Mesotænium macrococcum* (Kütz.) Roy & Biss. var. *micrococcum* (Kütz.) West & G. S. West. 1, × 520; 2 and 3, after De Bary, × 390	52
4–14.—	*M. chlamydosporum* De Bary. After De Bary, × 390	52
15–17.—	*M. caldariorum* (Lagerh.) Hansg. × 520	53
18–19.—	*M. mirificum* Arch. × 520	50
20–21.—	*M. Endlicherianum* Näg. 20, after Nägeli, × 300; 21, × 520	56
22.—	*M. Endlicherianum* var. *grande* Nordst. × 520	57
23–29.—	*Cylindrocystis Brébissonii* Menegh. 23, 24, 27–29, after De Bary, × 450; 25 and 26, × 520	58
32.—	*C. Brébissonii* Menegh. Young cells escaping from zygospore, after De Bary, × 390	58
33–38.—	*C. crassa* De Bary. 33–35, after De Bary, × 390; 36–38, × 520	59
39.—	*C. roseola* Turn. After Turner, × 500	62
40–41.—	*C. diplospora* Lund. 40, × 520; 41, after Lundell, × 400	61
42–43.—	*C. diplospora* var. *major* West. 42, × 400; 43, × 520	61

PLATE IV

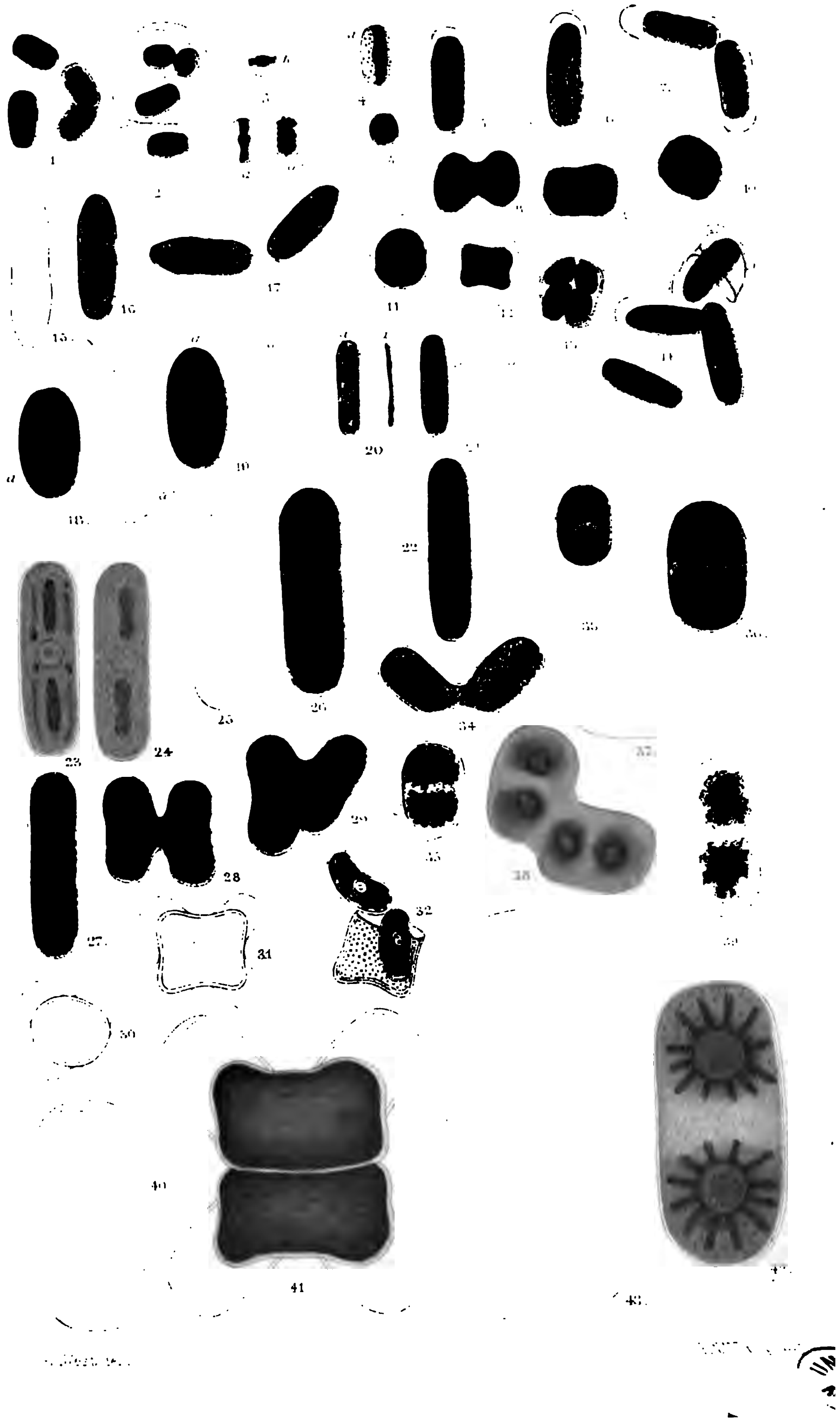

a
b

Plate 5

PLATE V.

FIGS.		PAGE
1–2.	—*Genicularia elegans* West & G. S. West. × 520	36
3–4.	—*G. spirotænia* De Bary. × 520. 4, zygospore	36
5.	—*Gonatozygon monotænium* De Bary. Zygospore, × 520	30
6.	—*Spirotænia trabeculata* A. Br. × 520	45
7.	—*Netrium oblongum* (De Bary) Lütkem. var. *cylindricum* West & G. S. West. × 520	67
8.	—*Cylindrocystis obesa* West & G. S. West. × 520	60
9.	—*Cyl. minutissima* Turn. × 520	62
10.	—*Cyl. Brébissonii* Menegh. Zygospore, × 520	58
11.	—*Cyl. Brébissonii* var. *minor* West & G. S. West. × 520	59
12.	—*Mesotænium truncatum* West & G. S. West. × 520	54

PLATE V

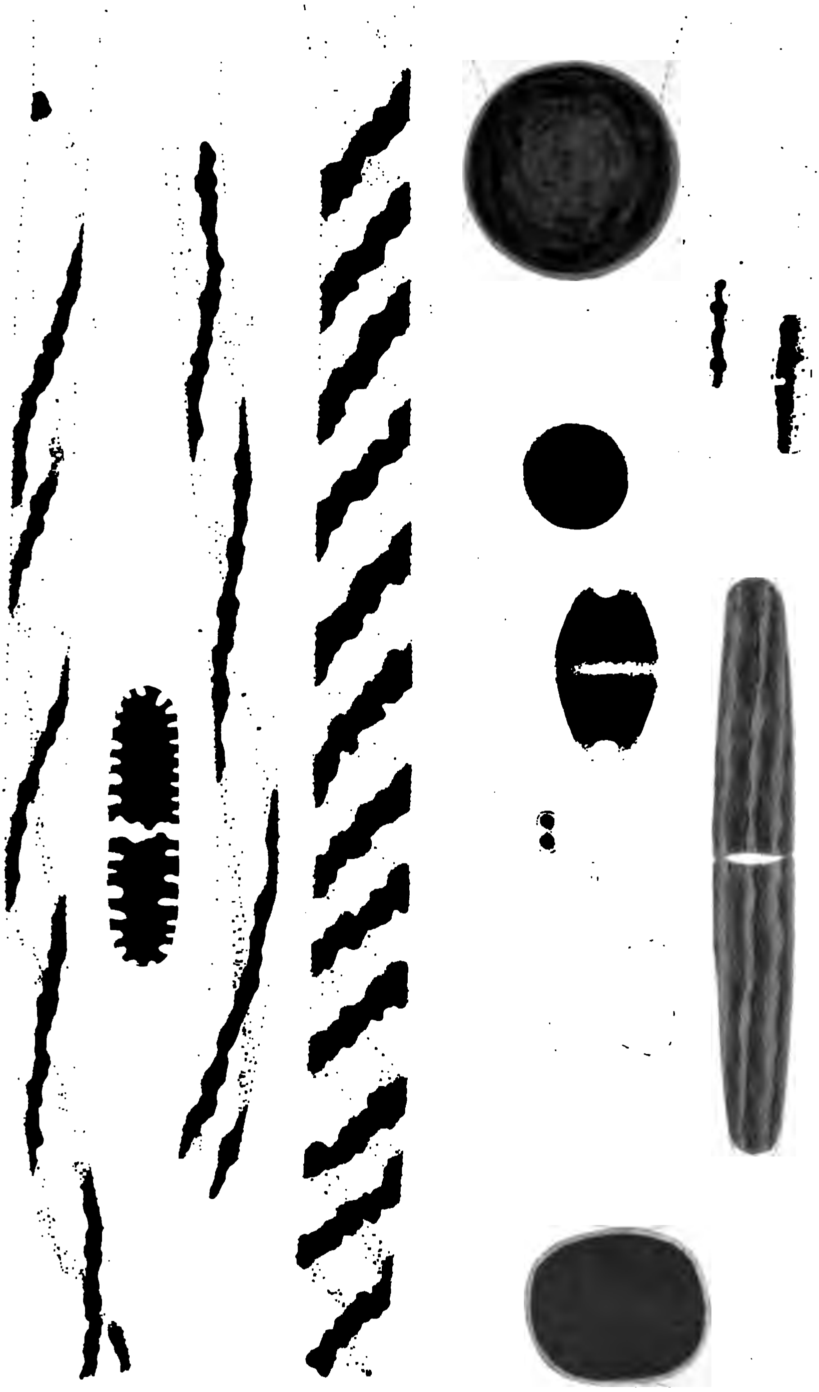
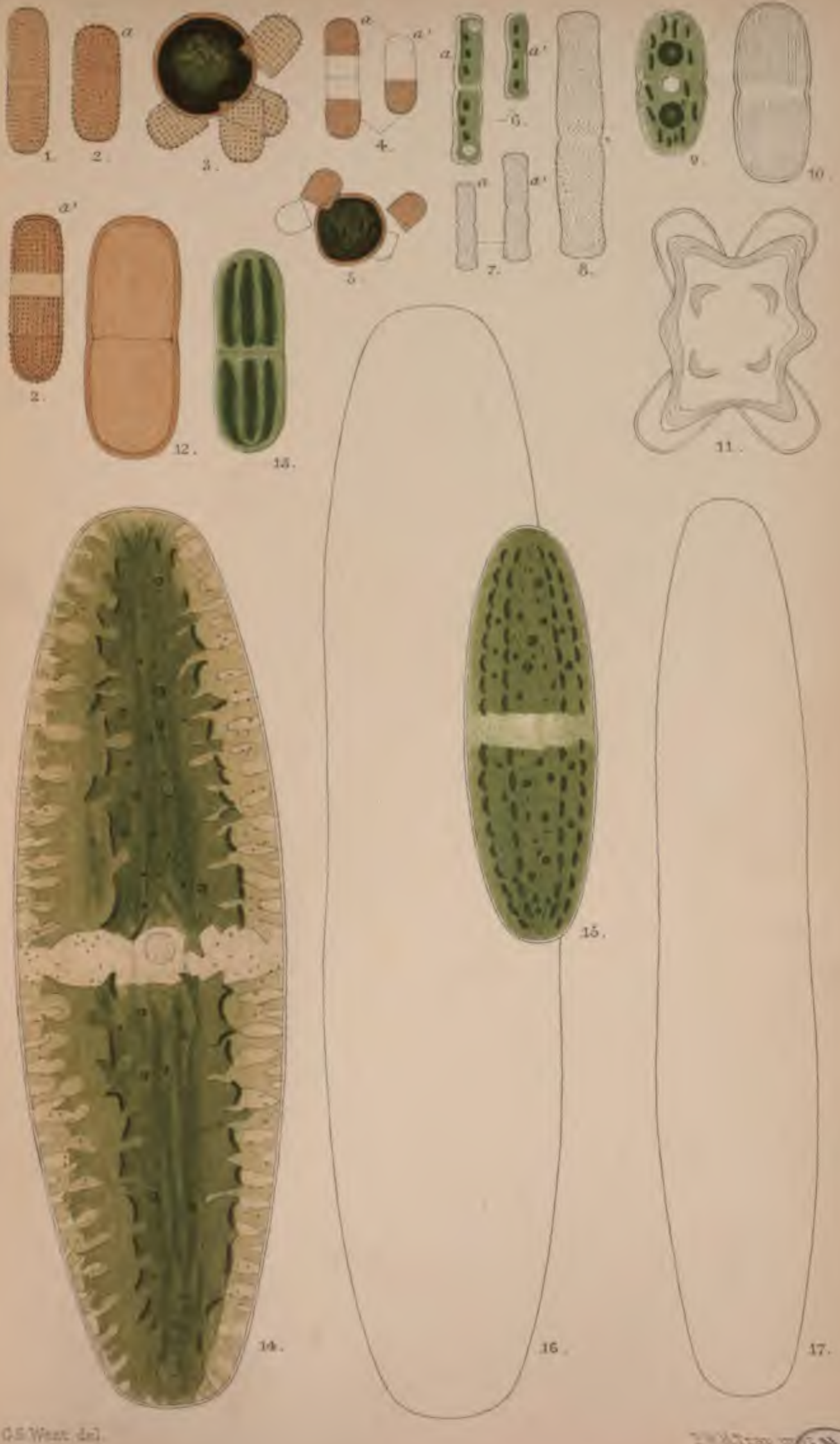


Plate 6

PLATE VI.

FIGS.		PAGE
1–3.	—*Penium Cylindrus* Ehrenb. 1, after Ralfs, × 400; 2 and 3, × 520; 3, zygospore	84
4–5.	—*P. cuticulare* West & G. S. West. × 520	85
6–7.	—*P. exiguum* West. × 400	86
8.	—*P. exiguum* forma *major* West & G. S. West. × 520	86
9–11.	—*P. phymatosporum* Nordst. After Nordstedt, × 570	91
12–13.	—*P. rufescens* Cleve. 12, × 520; 13, after Cleve, × 400	99
14–16.	—*Netrium Digitus* (Ehrenb.) Itzigsh. & Rothe. 14, × 520; 15, after Ralfs, × 200; 16, × 400	64
17.	—*N. Digitus* var. *constrictum* West. × 300	65

PLATE VI.



G.S. West del.

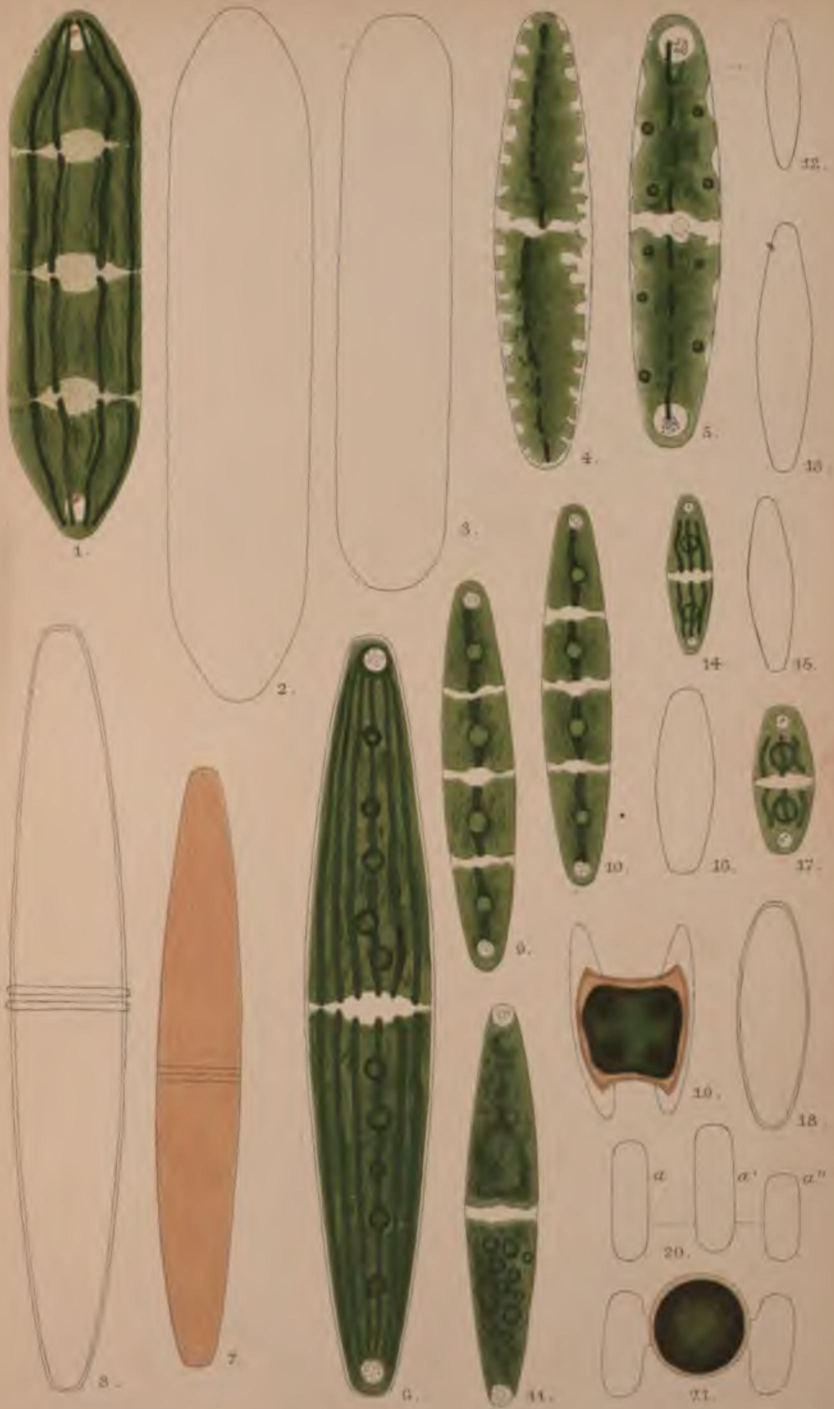
[illegible]

UNIV. OF MICH

Plate 7

PLATE VII.

FIGS.		PAGE
1–2.	—*Netrium interruptum* (Bréb.) Lütkem. 1, × 400; 2, × 520	68
3.	—*N. interruptum* var. *sectum* West. × 300	69
4–5.	—*N. Nägelii* (Bréb.) West & G. S. West. × 520	66
6–7.	—*Penium Libellula* (Focke) Nordst. 6, × 400; 7, × 220	73
8.	—*P. Libellula* forma. × 400	74
9–10.	—*P. Libellula* var. *interruptum* West & G. S. West. × 520	74
11.	—*P. Libellula* var. *intermedium* Roy & Biss. × 520	74
12–15.	—*P. Navicula* Bréb. 12, × 400; 13–15, × 520	75
16–17.	—*P. Navicula* var. *crassum* West & G. S. West. × 520	76
18.	—*P. Navicula* var. *inflatum* West & G. S. West. × 400	77
19.	—*P. Navicula*. Zygospore, after Lundell, × 400	75
20–21.	—*P. Jenneri* Ralfs. After Ralfs, × 200; 21, zygospore	77



G.S.West del.

J.W.Gray imp.

UNIV. OF MI

Plate 8

PLATE VIII.

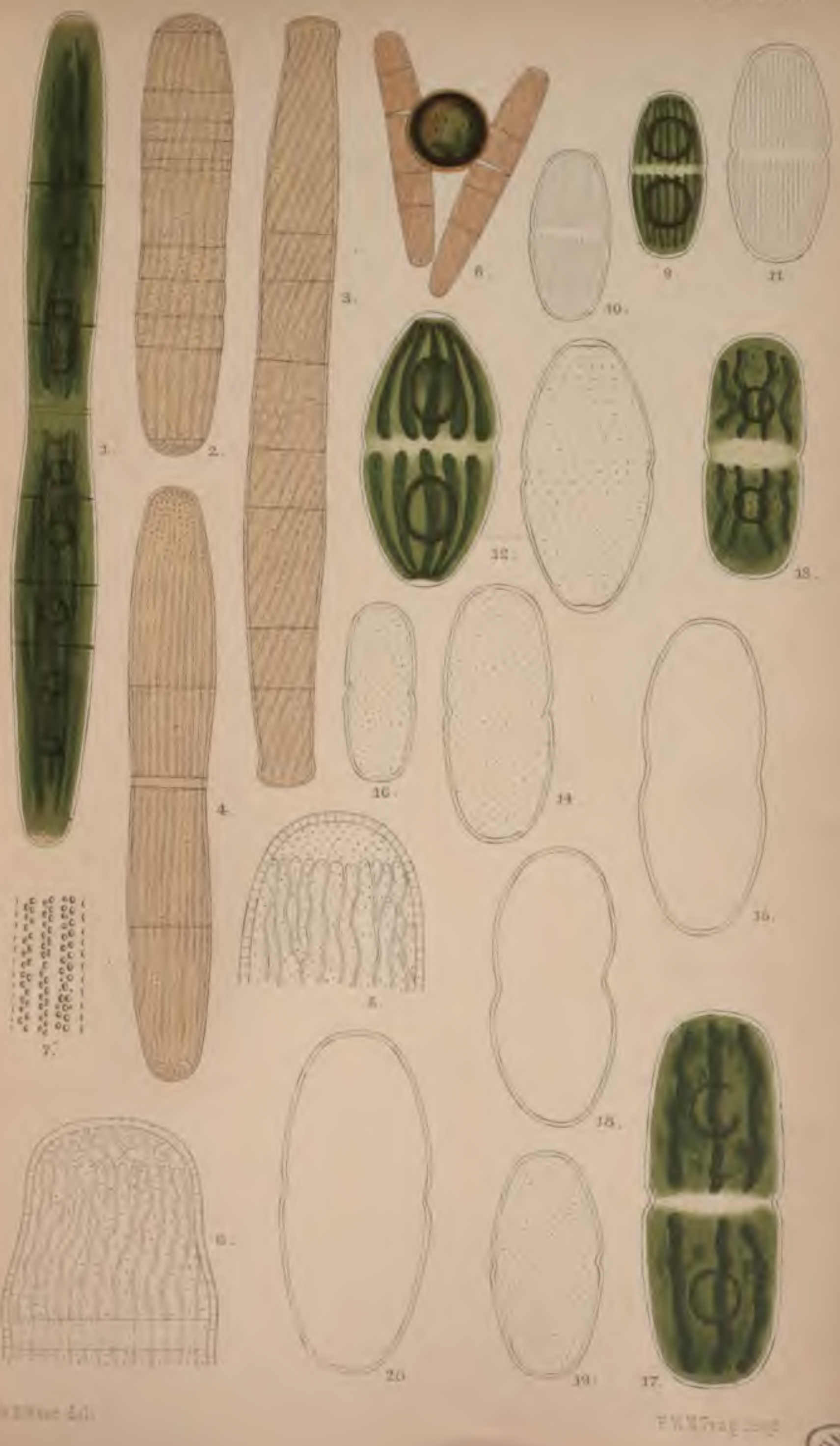
FIGS.		PAGE
1–3.	—*Netrium oblongum* (De Bary) Lütkem. 1 and 2, after De Bary, × 390; 3, × 400	66
4–5.	—*Penium crassiusculum* De Bary. 4, after De Bary, × 390; 5, × 520	96
6–7.	—*P. spinospermum* Joshua. 6, after Joshua, × 450; 7, × 520	78
8–10.	—*P. Mooreanum* Arch. After Archer, × 400	80
11–13.	—*P. didymocarpum* Lund. 11 and 12, after Lundell, × 400; 13, × 500	79
14–19.	—*P. suboctangulare* West. × 400	81
20–23.	—*P. minutissimum* Nordst. 20, × 500; 21–23, after Nordstedt, × 600	81
24–26.	—*P. truncatum* Bréb. 24 and 25, × 400; 26, zygospore, after Ralfs, × 400	82
27–29.	—*P. subtile* West & G. S. West. 27 and 29, × 520; 28, × 660	92
30–31.	—*P. adelochondrum* Elfv. 30, after Elfving, × 400; 31, × 400	93
32–35.	—*P. margaritaceum* Ralfs. 32, × 520; 33 and 34, × 400; 35, zygospore, after Ralfs, × 400	83
36–37.	—*P. Clevei* Lund. 36, × 400; 37, after Lundell, × 400	87
38.	—*P. Clevei* var. *crassum* West. × 520	88
39.	—*P. granulatum* (Benn.) West & G. S. West. After Bennett, × 400	87

Plate 9

PLATE IX.

FIGS.		PAGE
1–8.—	*Penium spirostriolatum* Barker. 1–4, × 520; 5 and 6, two apices, × 1280; 7, portion of cell-wall, × 1280; 8, zygospore, after Ralfs	88
9–11.—	*P. polymorphum* Perty. 9, after Lundell, × 400; 10, × 400; 11, × 520	90
12.—	*P. lagenarioides* Roy. After Roy, × 400	93
13–14.—	*P. Cucurbitinum* Biss. × 520	94
15.—	*P. Cucurbitinum* forma. × 520	96
16.—	*P. Cucurbitinum* forma *minor* West. × 400	95
17.—	*P. Cucurbitinum* forma *major* West & G. S. West. × 520	95
18.—	*P. Cucurbitinum* var. *Scoticum* West & G. S. West. × 400	96
19–20.—	*P. Cucurbitinum* var. *subpolymorphum* Nordst. 19, × 400; 20, after Nordstedt, × 570	95

PLATE IX.



G. S. West del.

[illegible]

UNIV OF MI

Plate 10

PLATE X.

FIGS.		PAGE
1–2.	—*Penium minutum* (Ralfs) Cleve. 1, × 400; 2, after De Bary, × 390	101
3.	—*P. minutum* forma *minor* Racib. × 400	103
4.	—*P. minutum* forma *major* Racib. × 400	103
5.	—*P. minutum* var. *tumidum* Wille. × 400	104
6.	—*P. minutum* var. *gracile* Wille. × 400	103
7.	—*P. minutum* var. *undulatum* West. × 400	105
8.	—*P. minutum* var. *elongatum* West & G. S. West. × 400	104
9.	—*P. minutum* var. *alpinum* Racib. × 400	104
10.	—*P. minutum* var. *polonicum* (Racib.) West & G. S. West. × 400	105
11–13.	—*P. minutum* var. *crassum* West. × 400	105
14.	—*P. minutum* var *crassum* forma *inflata* West. × 400	105
15–17.	—*P. inconspicuum* West. × 520	101
18–19.	—*P. cruciferum* (De Bary) Wittr. 18, × 625; 19, × 520	100
20.	—*P. cruciferum*, small form. × 520	
21–22.	—*P. curtum* Bréb. × 520	97
23.	—*P. curtum* forma *minor* Wille. × 520	98
24–25.	—*P. curtum* forma *major* Wille. × 520	98
26.	—*P. curtum* var. *obtusum* West & G. S. West. × 520	99
27.	—*Roya obtusa* (Bréb.) West & G. S. West. × 400	107
28–29.	—*R. obtusa* var. *montana* West & G. S. West. 28 and 29 *a*, × 625; 29 *a′*, × 520	108
30.	—*R. Pseudoclosterium* (Roy) West & G. S. West. × 520	109
31.	—*R. cambrica* West & G. S. West. × 520	108

PLATE X.

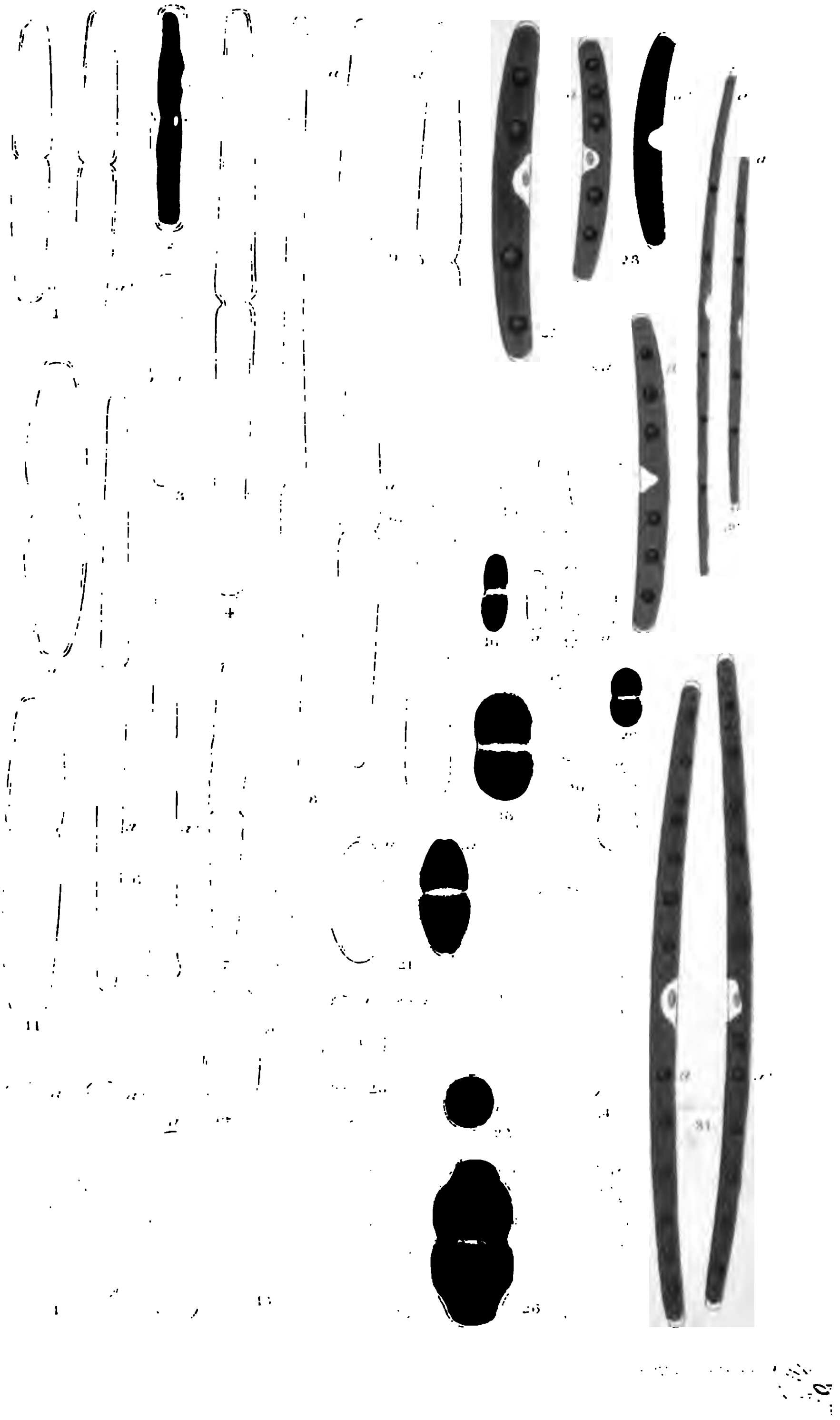
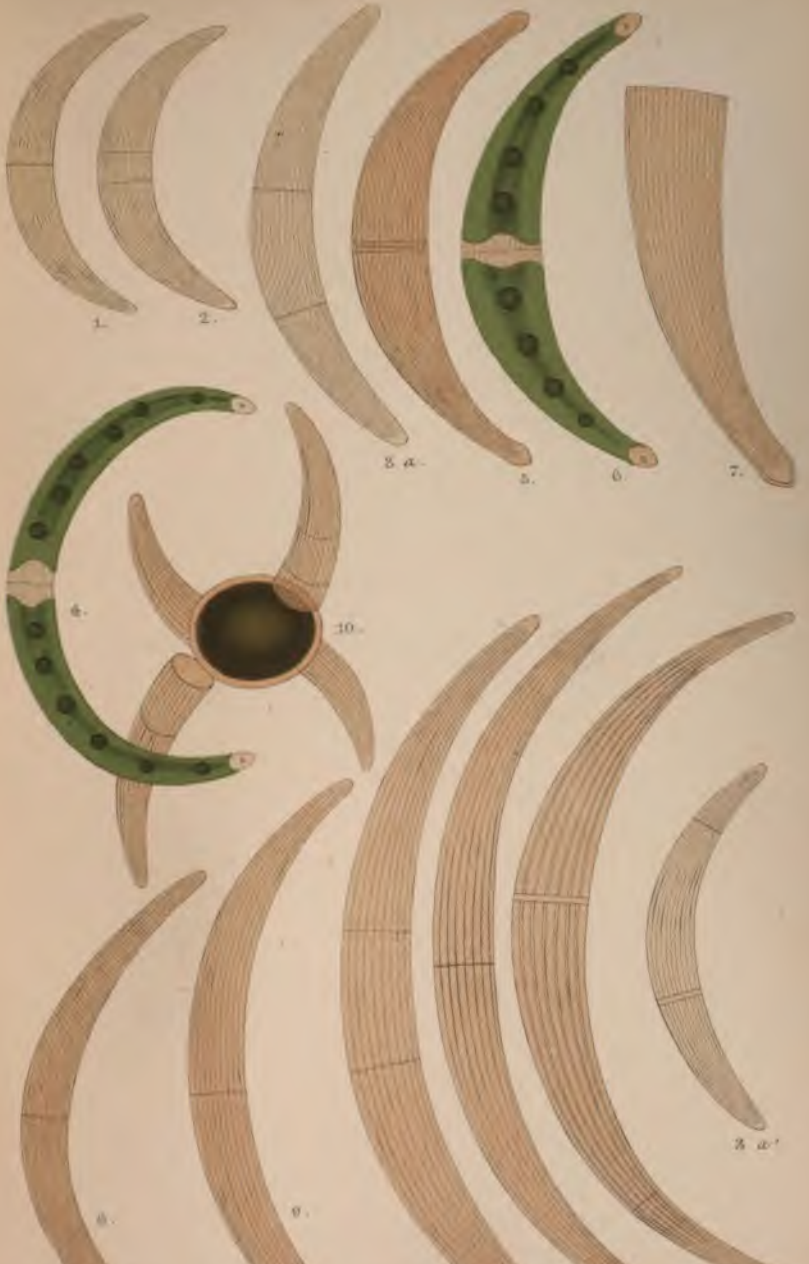


Plate 11

PLATE XI.

FIGS.	PAGE
1–3.—*Closterium Cynthia* De Not. 1 and 2, forms, × 520; 3 *a*, × 400 (after De Not.); 3 *a′*, × 400	113
4.—*Cl. Cynthia* var. *curvatissimum* West & G. S. West. × 520	114
5–7.—*Cl. Lagoense* Nordst. 5, × 400 (after Nordstedt). 6 and 7, × 520 . . .	114
8–10.—*Cl. Archerianum* Cleve. 8, × 400 (after Lundell); 9, × 400; 10, zygospore, × 400 (after Lütkemüller) . . .	115
11.—*Cl. Archerianum* forma. × 520 . .	115
12.—*Cl. porrectum* Nordst. × 400, after Nordstedt	116
13.—*Cl. porrectum* var. *angustatum* West & G. S. West. × 520	116



T. West del.

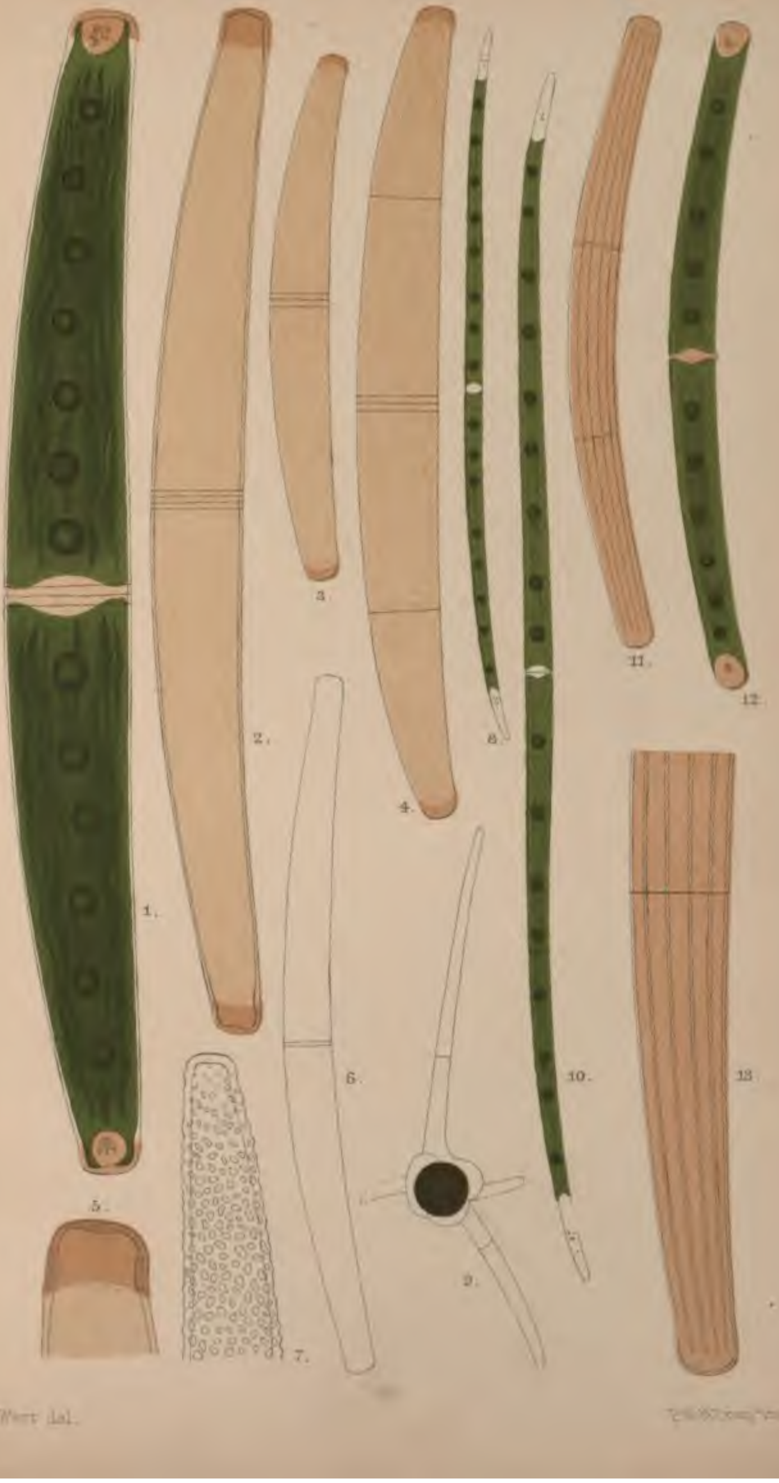
P. W. M. Trap impr.

Plate 12

PLATE XII.

FIGS.		PAGE
1–5.	—*Closterium didymotocum* Corda. 1 and 2, × 400; 3 and 4, × 200 (after Ralfs); 5, apex of semicell, × 700	116
6–7.	—*Cl. didymotocum* var. *asperulatum* West & G. S. West. 6, × 220; 7, × 520	118
8–10.	—*Cl. macilentum* Bréb. 8 and 9, × 200 (after Brébisson); 10, × 220	118
11–13.	—*Cl. angustatum* Kütz. 11 and 12, × 220; 13, × 520	119

PLATE XII.



G.S.West del.

West,Newman imp.

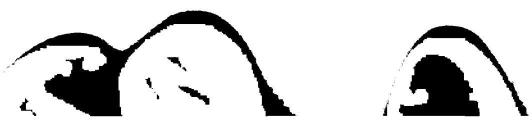
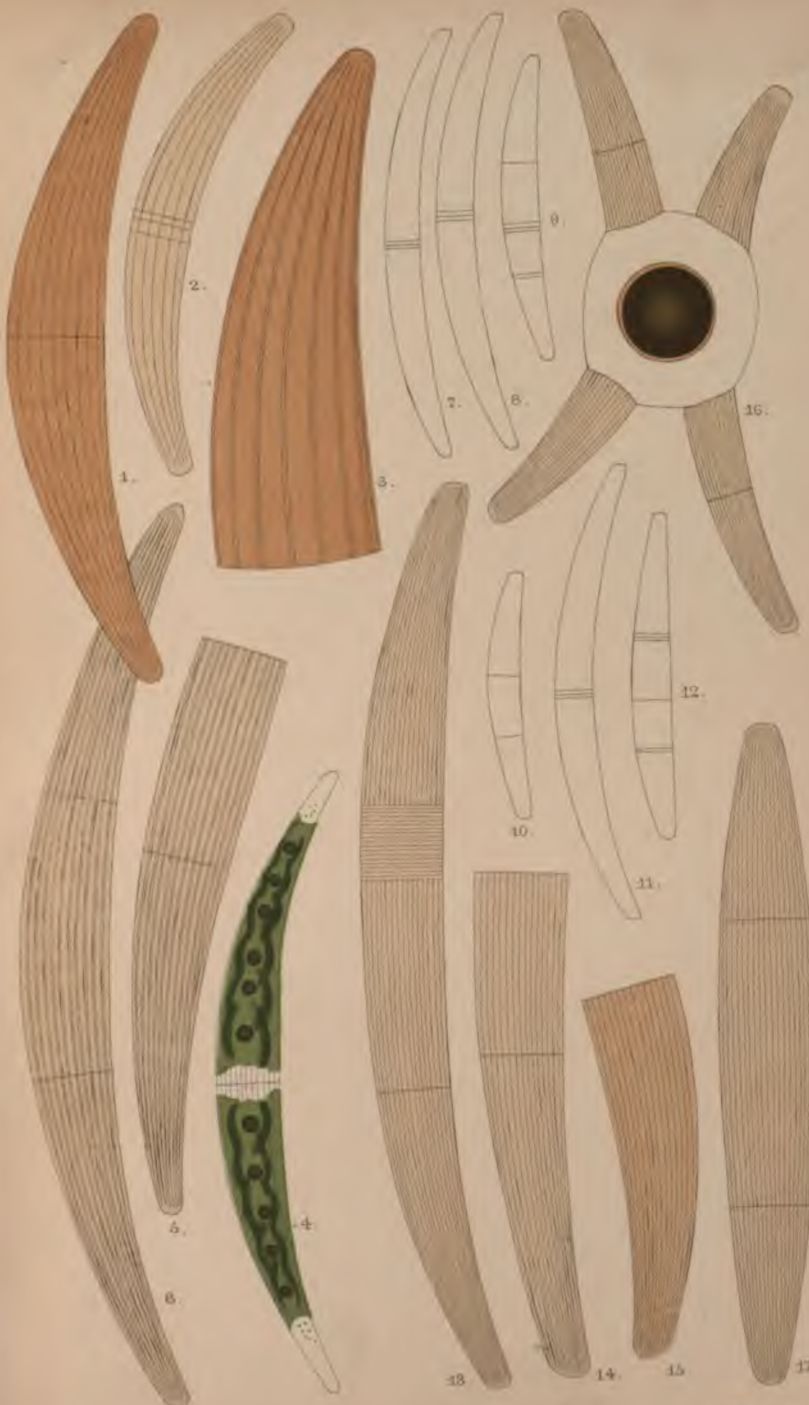


Plate 13

PLATE XIII.

FIGS.		PAGE
1–3.	—*Closterium costatum* Corda. 1, × 220; 2, × 200 (after Ralfs); 3, × 520	120
4–6.	—*Cl. regulare* Bréb. 4, × 200 (after Brébisson); 5 and 6, × 520	122
7–16.	—*Cl. striolatum* Ehrenb. 7–12, outline figures to show the variability of form and the sutures, × 140; 13, × 400; 14 and 15, × 520; 16, zygospore, × 200 (after Ralfs)	122
17.	—*Cl. striolatum* forma *recta* West. × 400	124



G.S.West del.

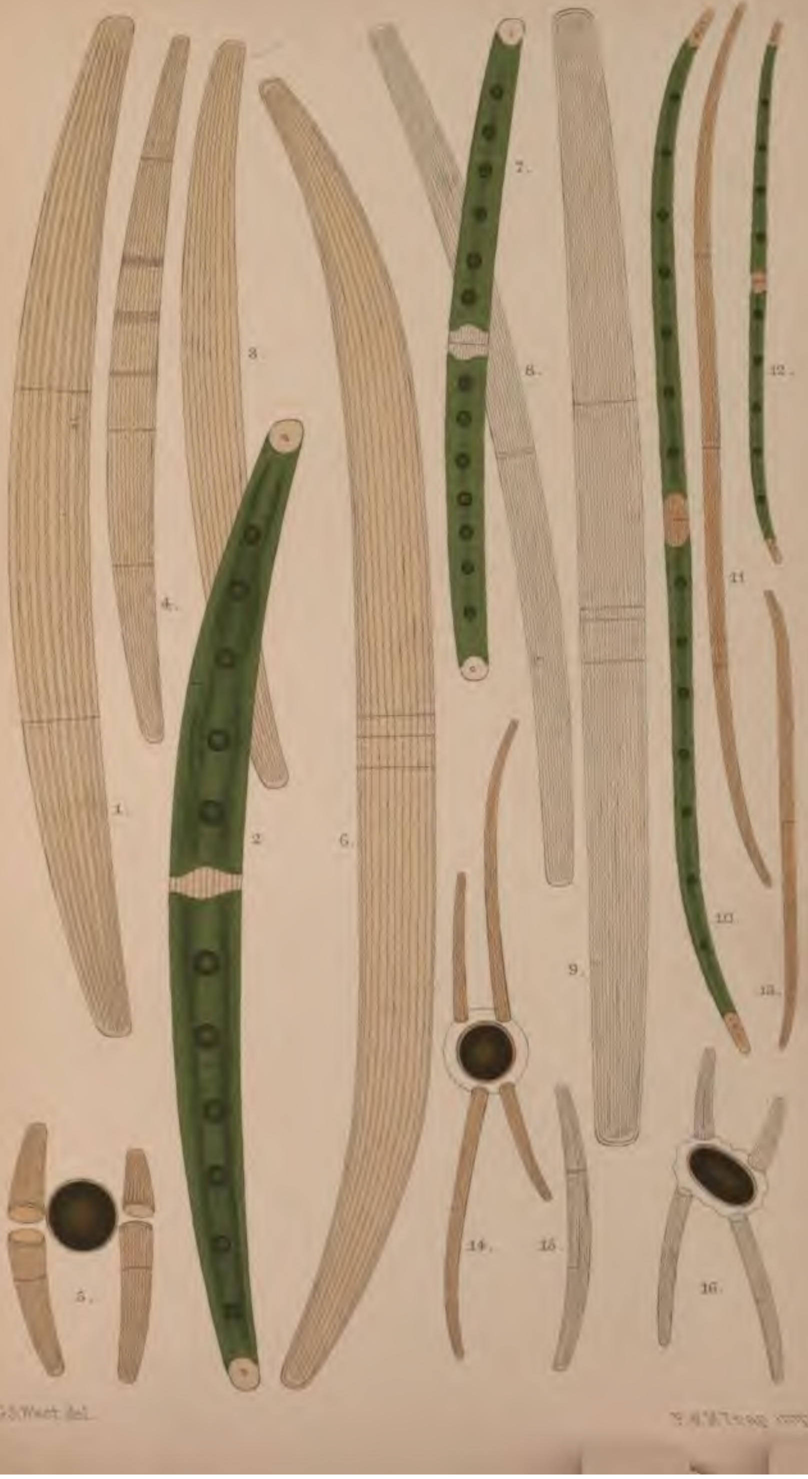
West, Newman imp.

Plate 14

PLATE XIV.

FIGS.	PAGE
1–5.—*Closterium intermedium* Ralfs. 1–3, × 520; 4–5, × 200 (after Ralfs) . . .	125
6.—*Cl. intermedium* var. *hibernicum* West. × 520	126
7–9.—*Cl. Ulna* Focke. 7 and 8, × 400; 9, × 520 .	127
10–14.—*Cl. juncidum* Ralfs. 10–13, × 400; 14, zygospore, × 200 (after Ralfs) . .	128
15–16.—*Cl. juncidum* var. *brevior* Roy. × 200 (after Ralfs)	129

PLATE XIV



G.S.West del.

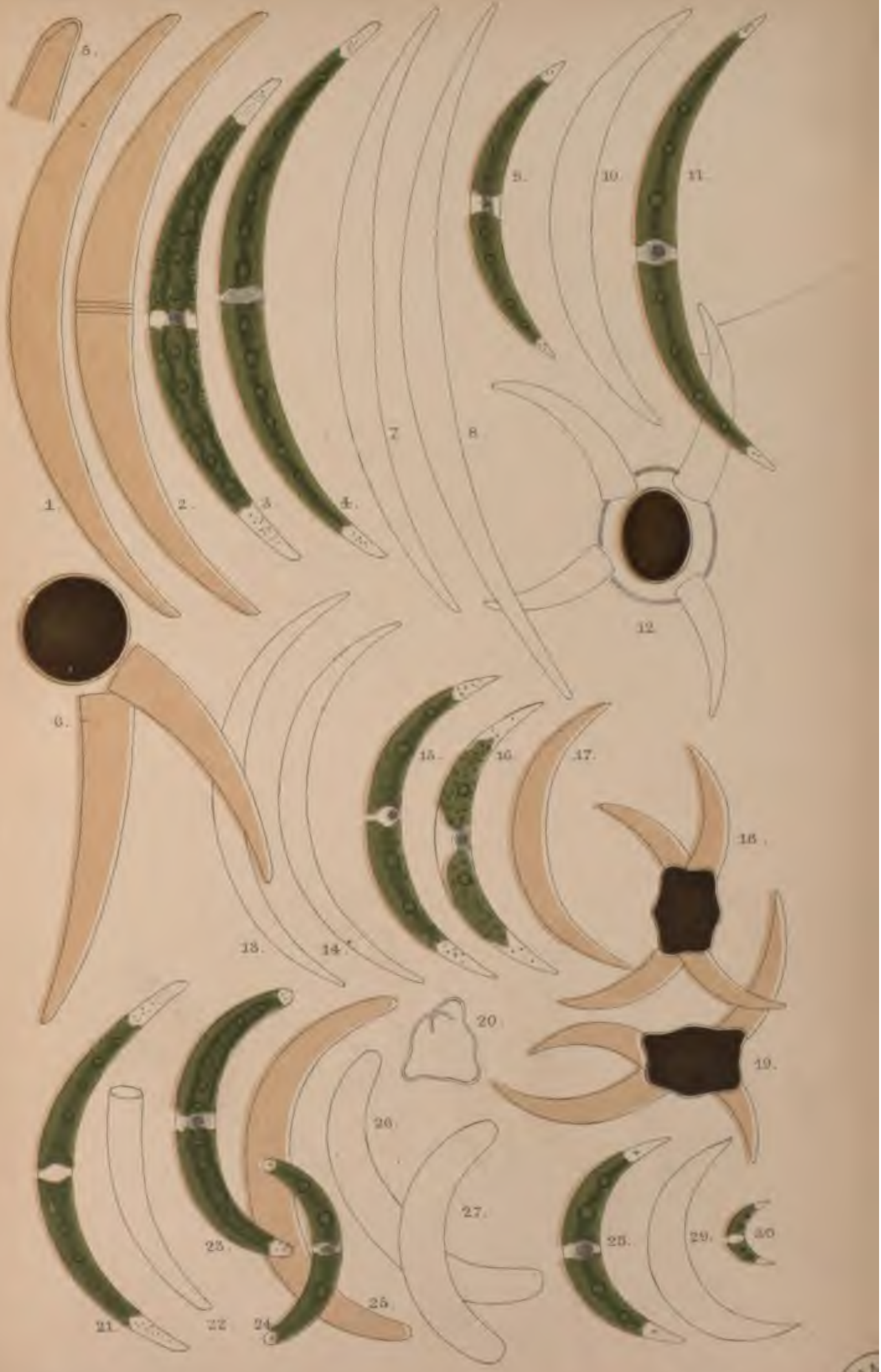
[illegible]

Plate 15

PLATE XV.

FIGS.		PAGE
1–6.	—*Closterium Dianæ* Ehrenb. 1–3, × 220; 4, × 200 (after Ralfs); 5, extremity of cell, × 830; 6, zygospore, × 220 . .	130
7–8.	—*Cl. Pseudodianæ* Roy. 7, × 400 (after Roy); 8, × 400	132
9–12.	—*Cl. parvulum* Näg. 9, × 300 (after Nägeli); 10 and 11, × 520; 12, zygospore, × 300 .	133
13–14.	—*Cl. parvulum* var. *angustum* West & G. S. West. × 520	134
15–20.	—*Cl. Venus* Kütz. × 520; 18–20, zygospores .	137
21–22.	—*Cl. Dianæ* var. *arcuatum* (Bréb.) Rabenh. × 220 (after Brébisson) . . .	131
23–25.	—*Cl. Jenneri* Ralfs. 23, × 200 (after Ralfs); 24 and 25, × 520 . . .	134
26–27.	—*Cl. Jenneri* var. *robustum* G. S. West. × 520 .	136
28–30.	—*Cl. incurvum* Bréb. 28 and 29, × 520; 30, × 200 (after Brébisson) . . .	136

PLATE XV.



G.S.West del.

P.M.M.Trap impr.

Plate 16

PLATE XVI.

FIGS.		PAGE
1–4.	—*Closterium calosporum* Wittr. × 400 (after Wittrock). 3 and 4, zygospores	138
5–6.	—*Cl. calosporum* forma *major* West & G. S. West. Two zygospores, × 220	139
7–8.	—*Cl. eboracense* Turn. × 400; 7, after Turner	140
9–14.	—*Cl. Leibleinii* Kütz. 9–11, × 200 (after Ralfs); 12–14, × 520	141
15–16.	—*Cl. moniliferum* Ehrenb. × 400	142

PLATE XVI

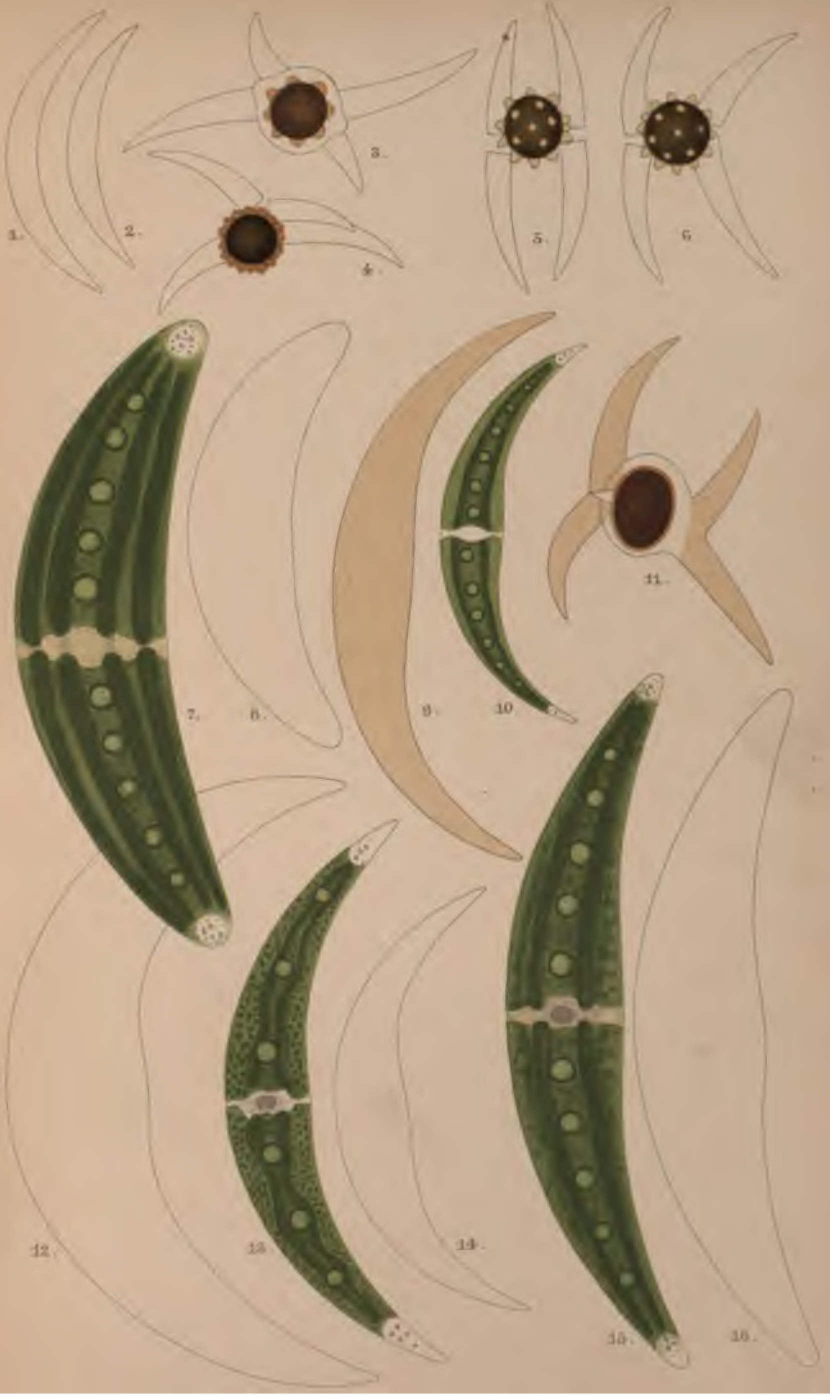
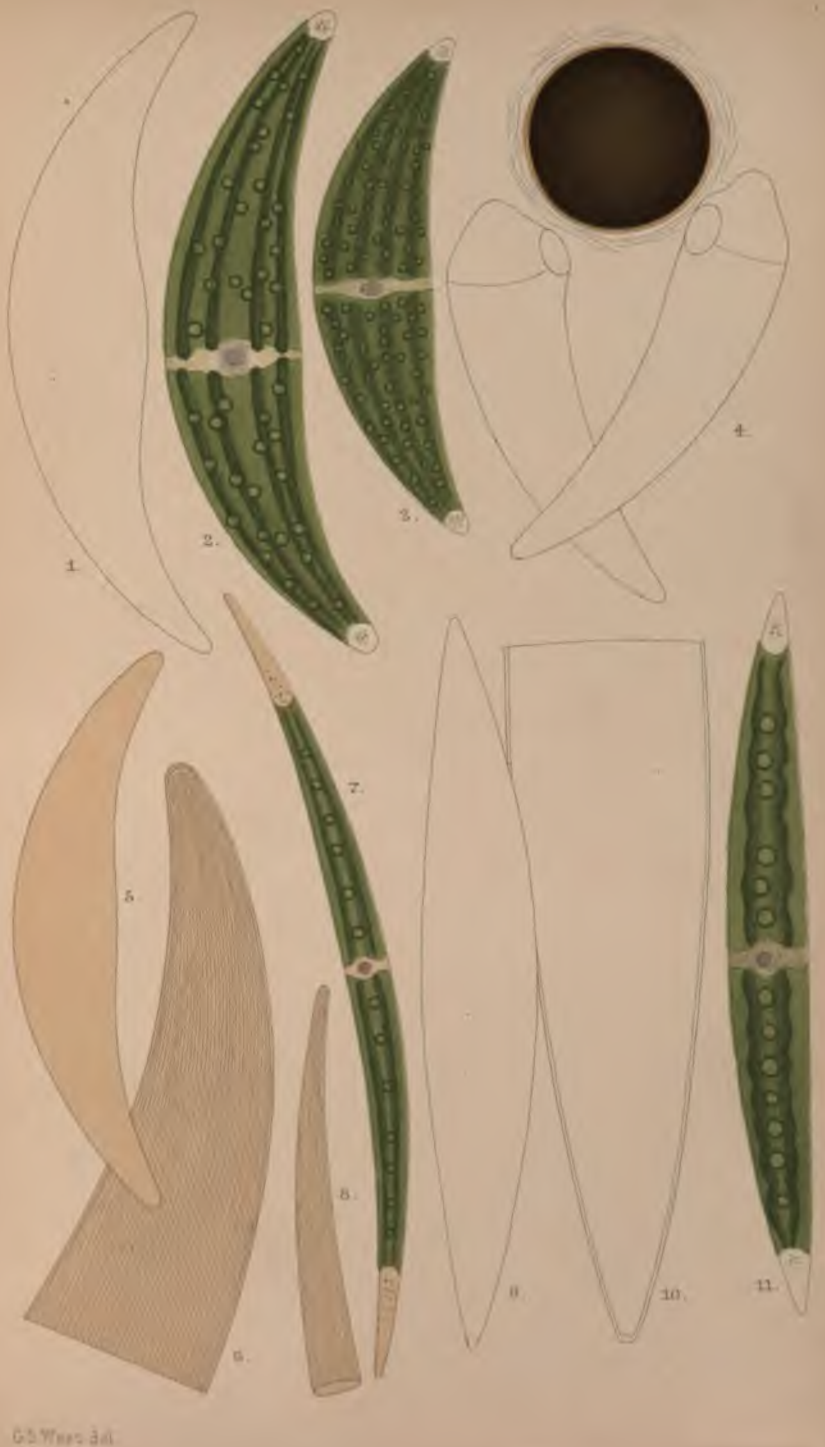


Plate 17

PLATE XVII.

FIGS.		PAGE
1–4.	—*Closterium Ehrenbergii* Menegh. 1 and 2, × 220; 3, × 120; 4, zygospore, × 220	143
5–6.	—*Cl. Malinvernianum* De Not. 5, × 220; 6, × 520	145
7–8.	—*Cl. decorum* Bréb. × 200 (after Brébisson)	184
9–10.	—*Cl. lanceolatum* Kütz. 9, × 300; 10, × 520	149
11.	—*Cl. lanceolatum* var. *parvum* West & G. S. West. × 520	150

PLATE XVII.



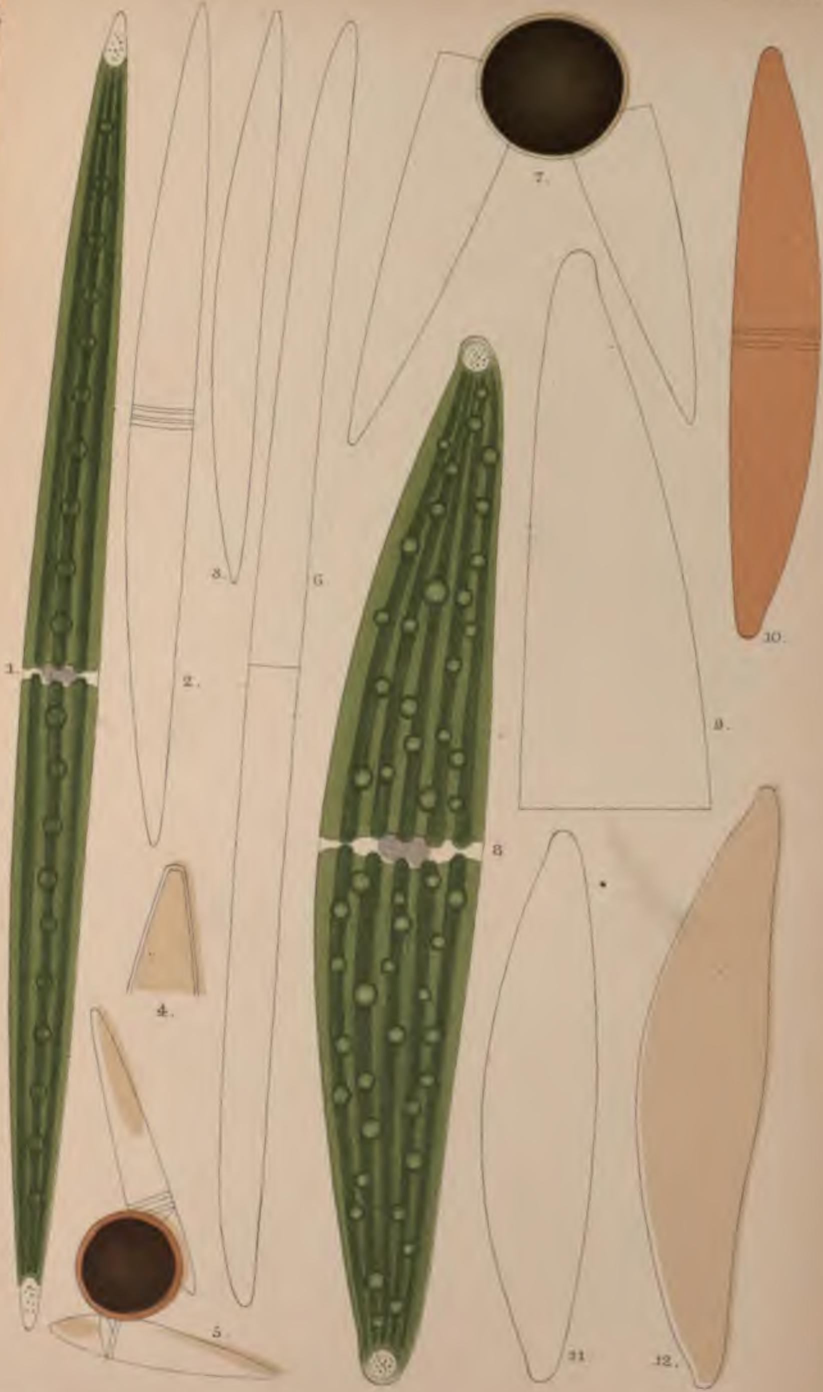
G.S.West del.

Plate 18

PLATE XVIII.

FIGS.		PAGE
1.	—*Closterium acerosum* (Schrank) Ehrenb. var. *elongatum* Bréb. × 220	148
2–5.	—*Cl. acerosum* (Schrank) Ehrenb. 2 and 3, × 200 (after Ralfs); 4, extremity of a cell showing slight truncation, × 520; 5, zygospore, × 200 (after Ralfs)	146
6.	—*Cl. acerosum* var. *angolense* West & G. S. West. × 220	149
7.	—*Cl. lanceolatum* Kütz. Zygospore, × 220	149
8–9.	—*Cl. Lunula* Ehrenb. × 220	150
10.	—*Cl. Lunula* var. *coloratum* Klebs. × 120	152
11.	—*Cl. Lunula* var. *biconvexum* Schmidle. × 120	152
12.	—*Cl. Lunula* var. *intermedium* Gutw. × 120	152

PLATE XVIII



G.S.West del.

West, Newman imp.

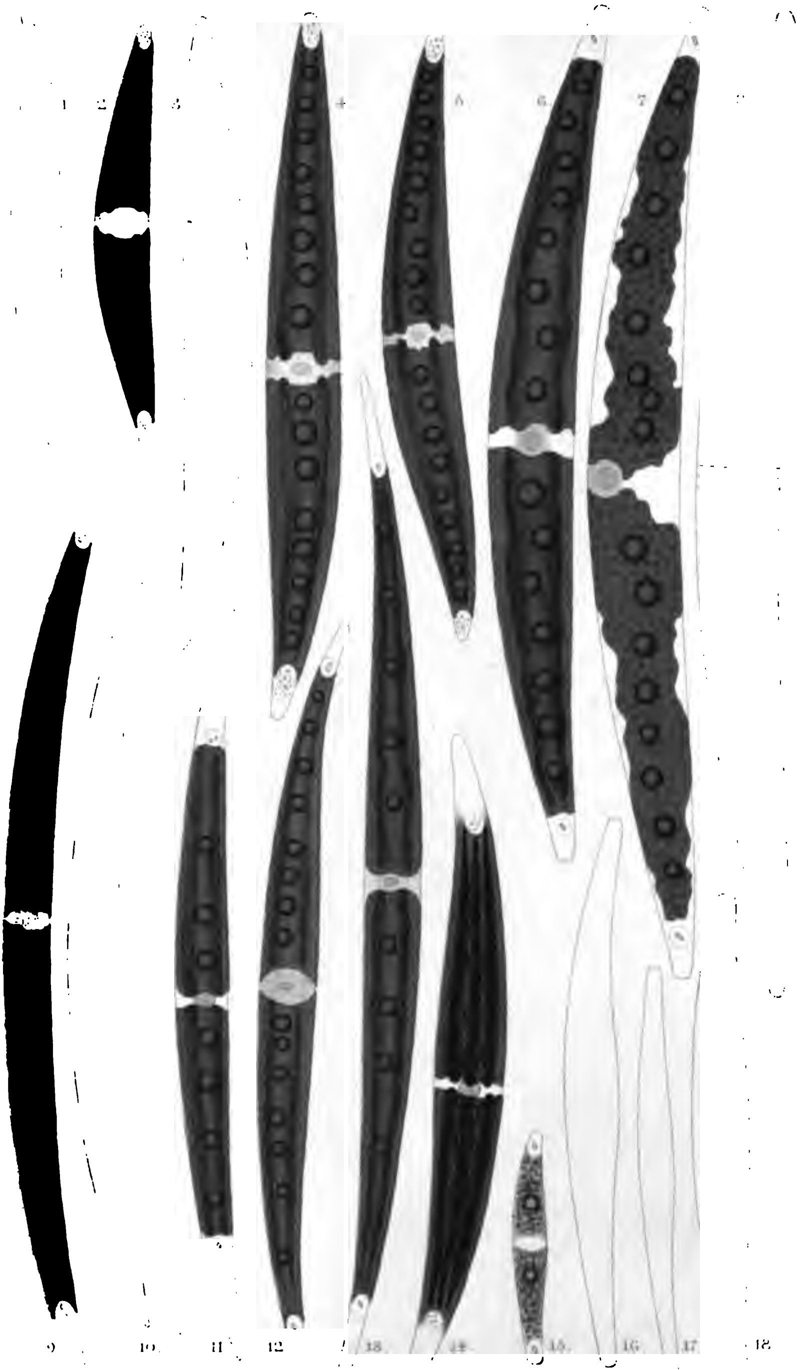
UNI

Plate 19

PLATE XIX.

FIGS.		PAGE
1–2.	—*Closterium sigmoideum* Lagerh. & Nordst. × 170	153
3–5.	—*Cl. sigmoideum* forma *major* West & G. S. West. × 170	153
6–8.	—*Cl. Siliqua* West & G. S. West. × 520	154
9–11.	—*Cl. peracerosum* Gay. 9 and 10, × 400; 11, × 400 (after Gay)	154
12–13.	—*Cl. peracerosum* var. *elegans* G. S. West. × 520	155
14.	—*Cl. littorale* Gay. × 400 (after Gay)	155
15–18.	—*Cl. tumidum* Johnson. × 520	156

PLATE XIX

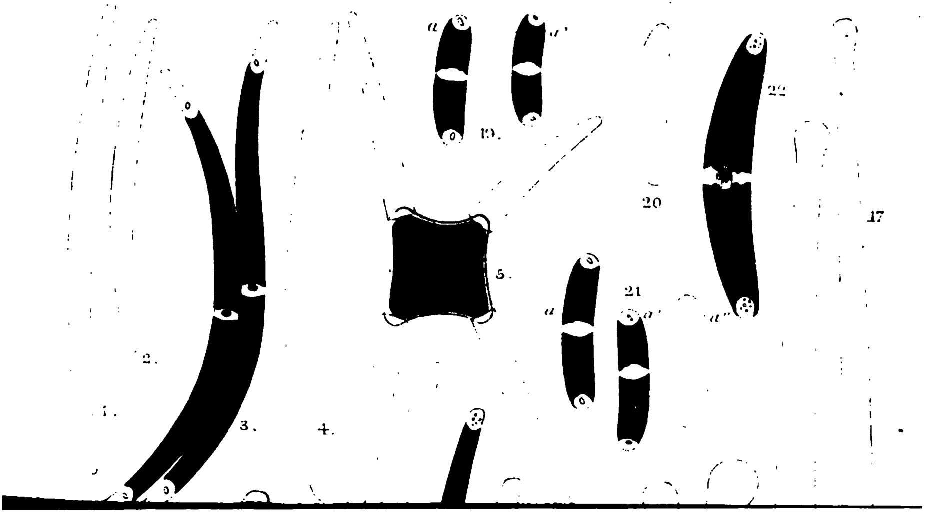


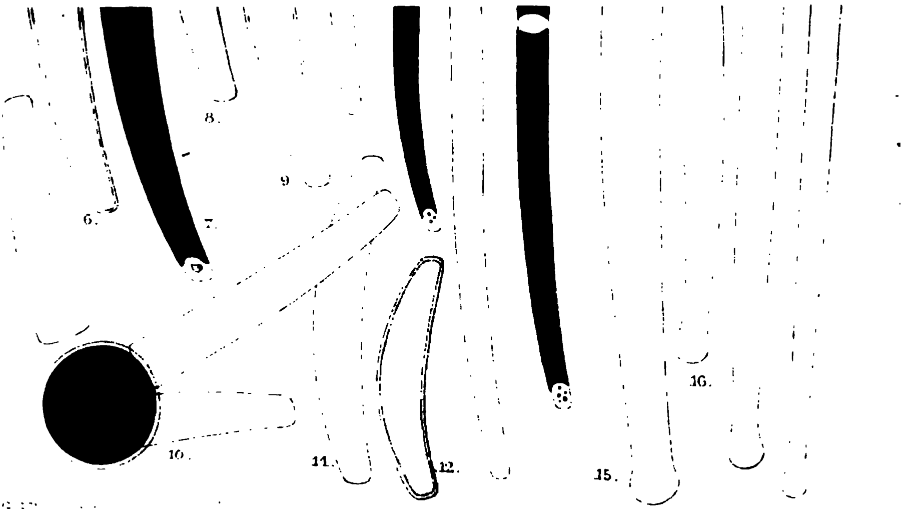
UNIV. OF MICH.

Plate 20

PLATE XX.

FIGS.		PAGE
1–5.	—*Closterium Cornu* Ehrenb. 1 and 2, × 400; 3 and 4, × 520; 5, zygospore, × 400	157
6–10.	—*Cl. abruptum* West. × 520. 10, zygospore	158
11–12.	—*Cl. abruptum* var. *brevius* West & G. S. West. × 400	160
13–14.	—*Cl. toxon* West. × 400	160
15.	—*Cl. Balmacarense* Turn. × 400 (after Turner)	161
16.	—*Cl. Balmacarense* forma *minor* Turn. × 400 (after Turner)	161
17.	—*Cl. Scoticum* Turn. × 400 (after Turner)	161
18.	—*Cl. Scoticum* var. *fusiforme* Turn. × 400 (after Turner)	162
19.	—*Cl. pusillum* Hantzsch var. *major* Racib.	163
20–24.	—*Cl. pusillum* var. *monolithum* Wittr.	163





G.S.West del.

P.W.M.Trap impr.

UNIV. OF

Plate 21

PLATE XXI.

FIGS.		PAGE
1–2.	—*Closterium prælongum* Bréb. 1, × 200 (after Brébisson); 2, × 500	164
3–5.	—*Cl. prælongum* forma *brevior* West. 3 and 4, × 400; 5, zygospore, × 200	165
6–7.	—*Cl. strigosum* Bréb. × 400	165
8–12.	—*Cl. gracile* Bréb. × 520; 11 and 12, zygospores	166
13.	—*Cl. gracile* var. *tenue* (Lemm.) West & G. S. West. × 520	168
14–16.	—*Cl. gracile* var. *elongatum* West & G. S. West. × 400	168
17.	—*Cl. Lundellii* Lagerh. × 400	169
18–19.	—*Cl. aciculare* Tuffen West. × 400	174

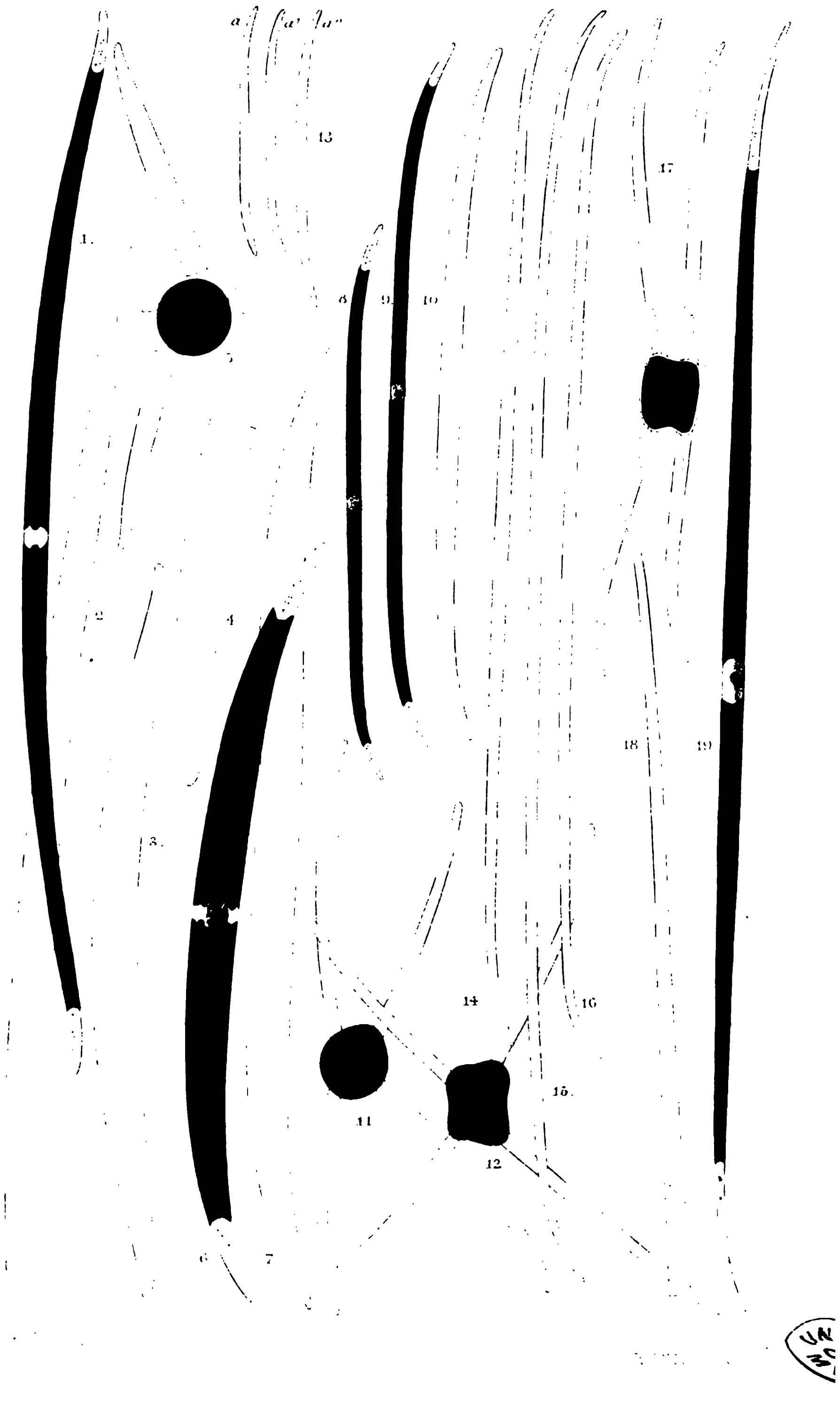
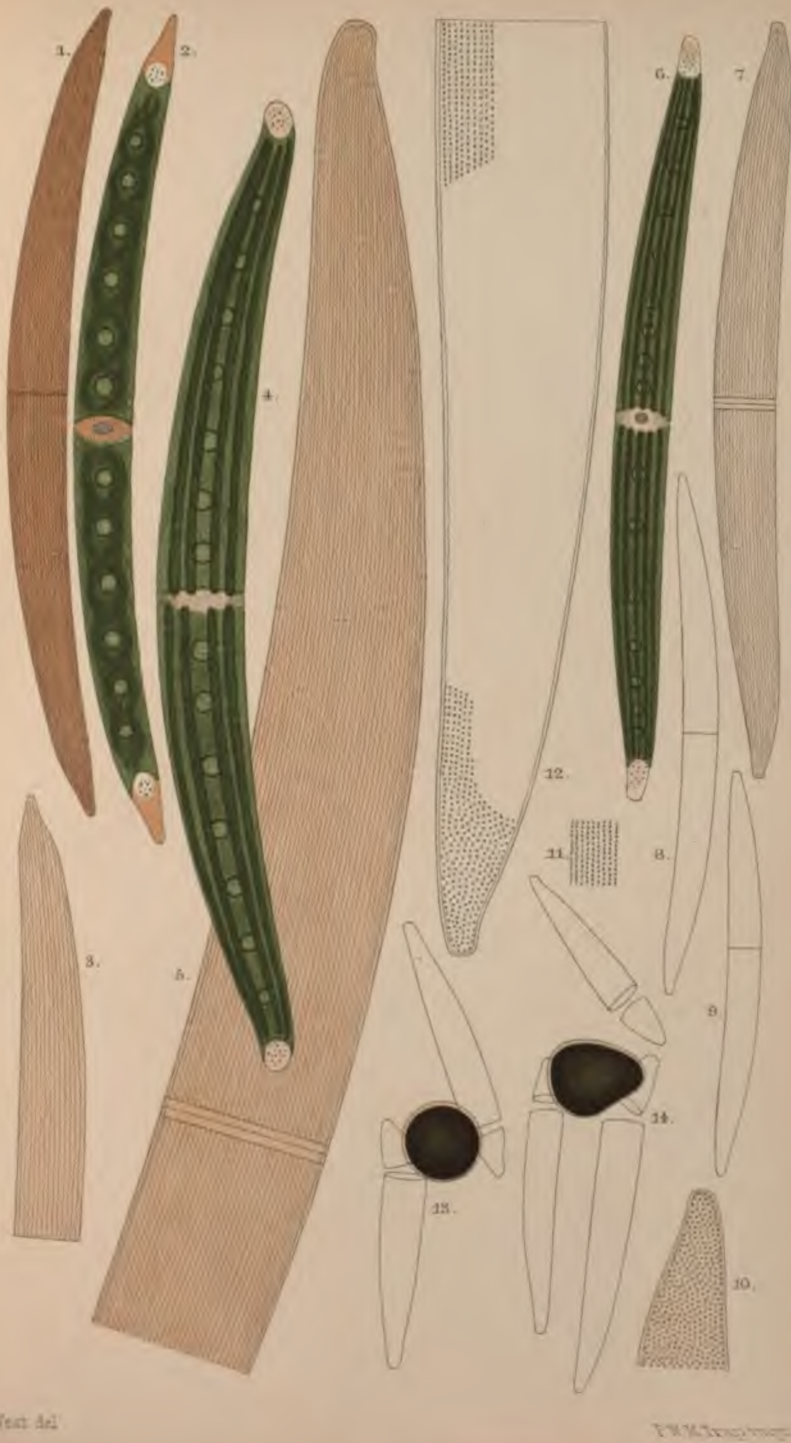

a
a'
a''
13
1.
5
8
9
10
17
2
4
3.
18
19
14
16
11
12
15.
6
7

Plate 22

PLATE XXII.

FIGS.		PAGE
1–3.	—*Closterium attenuatum* Ehrenb. × 220 .	169
4–5.	—*Cl. turgidum* Ehrenb. 4, × 200 (after Ralfs); 5, × 400	170
6–14.	—*Cl. Pritchardianum* Arch. 6 and 7, × 200 (after Archer); 8 and 9, outline drawings, × 120; 10, apex of semicell, × 520; 11, part of cell-wall showing dotted striæ, × 520; 12, semicell with prominent marks, × 520; 13 and 14, zygospores, × 120; 14 is an abnormal zygospore produced by the conjugation of three cells . . .	172

PLATE XXII.



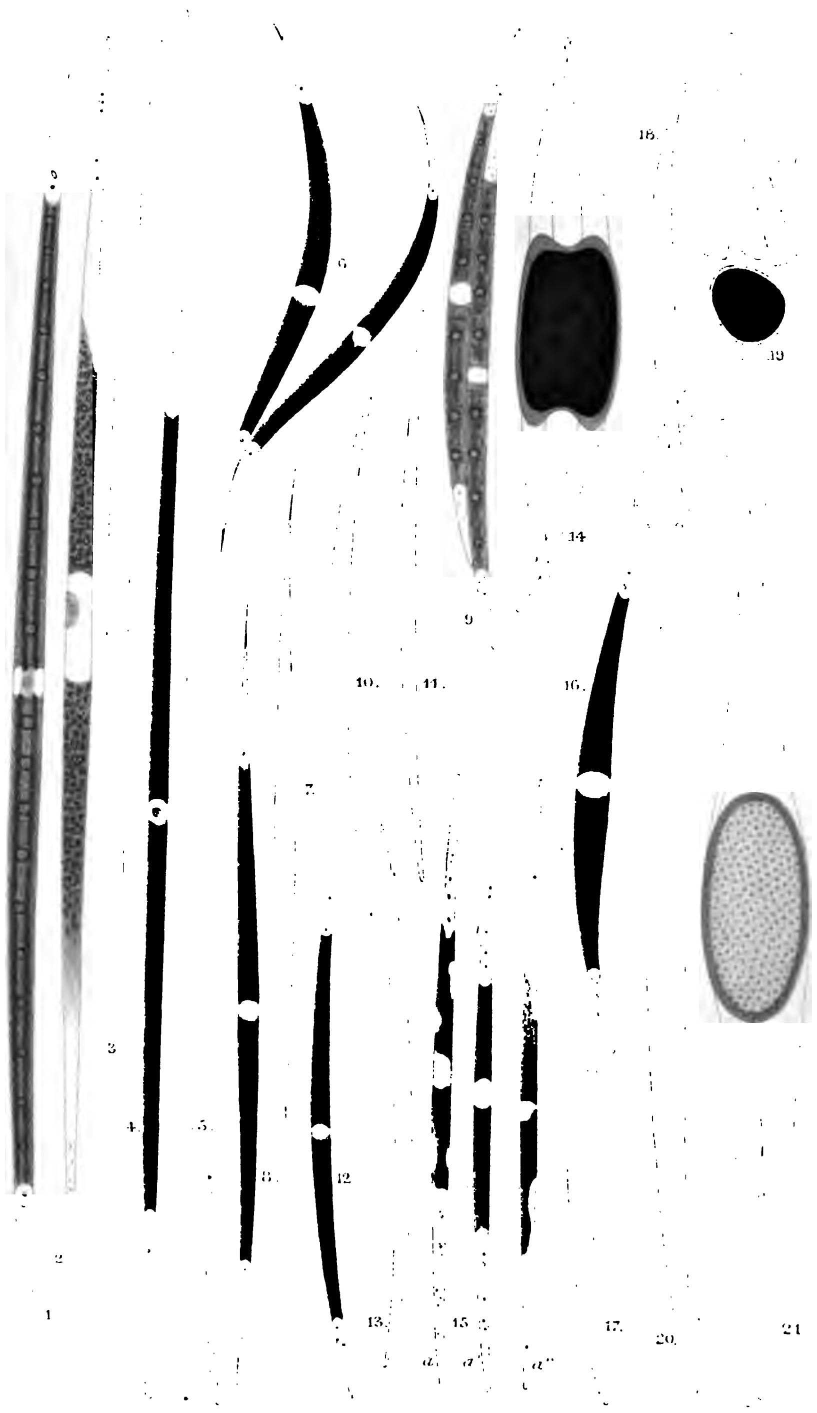
G.S.West del.

Plate 23

PLATE XXIII.

FIGS.		PAGE
1–3.	—*Closterium pronum* Bréb. × 520 . .	173
4–5.	—*Cl. aciculare* Tuffen West var. *subpronum* West & G. S. West. × 520 . .	175
6–8.	—*Cl. Ceratium* Perty. 6, × 520; 7 and 8, × 400	176
9–14.	—*Cl. acutum* Bréb. × 520; 14, zygospore .	177
15.	—*Cl. acutum* var. *Linea* (Perty) West & G. S. West. × 520	178
16–19.	—*Cl. subulatum* Kütz. 16 and 17, × 400; 18, smaller forms, × 520; 19, zygospore, × 520 .	179
20–21.	—*Cl. idiosporum* West & G. S. West. × 520 .	180

PLATE XXIII.



G.S.West del.

W.M. imp.

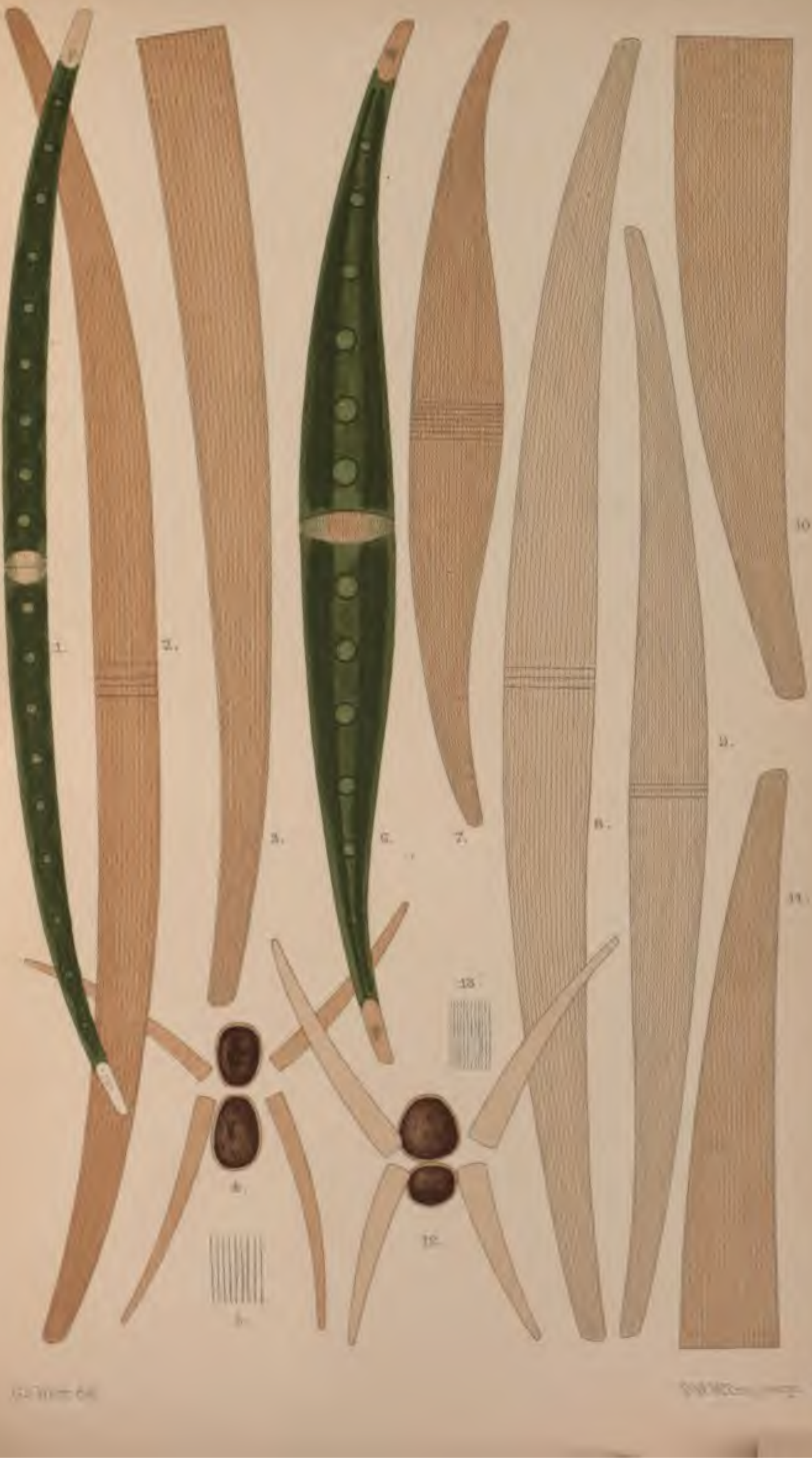
UNIV. OF MICH

Plate 24

PLATE XXIV.

FIGS.		PAGE
1–5.	—*Closterium lineatum* Ehrenb. 1, × 200 (after Ralfs); 2, × 400; 3, × 520; 4, zygospore, × 120; 5, portion of cell-wall of conjugating specimen, × 520 . . .	181
6–7.	—*Cl. Ralfsii* Bréb. 6, × 300; 7, × 200 (after Ralfs)	182
8–13.	—*Cl. Ralfsii* var. *hybridum* Rabenh. 8, 10, and 11, × 520; 9, × 220; 12, zygospore, × 120; 13, portion of cell-wall of conjugating specimen, × 520	183

PLATE XXIV.



G. West del.

W. West & Co. imp.

Plate 25

PLATE XXV.

FIGS.		PAGE
1–3.	—*Closterium decorum* Bréb. 1 and 2, × 208 (after Delponte) ; 3, × 520	184
4–5.	—*Cl. laterale* Nordst. 4, × 220 ; 5, × 520	186
6–11.	—*Cl. Kützingii* Bréb. 6, × 500 ; 7–9, × 520 ; 10 and 11, zygospores, × 400	186
12–13.	—*Cl. Kützingii* var. *vittatum* Nordst. × 520	188

PLATE XXV.

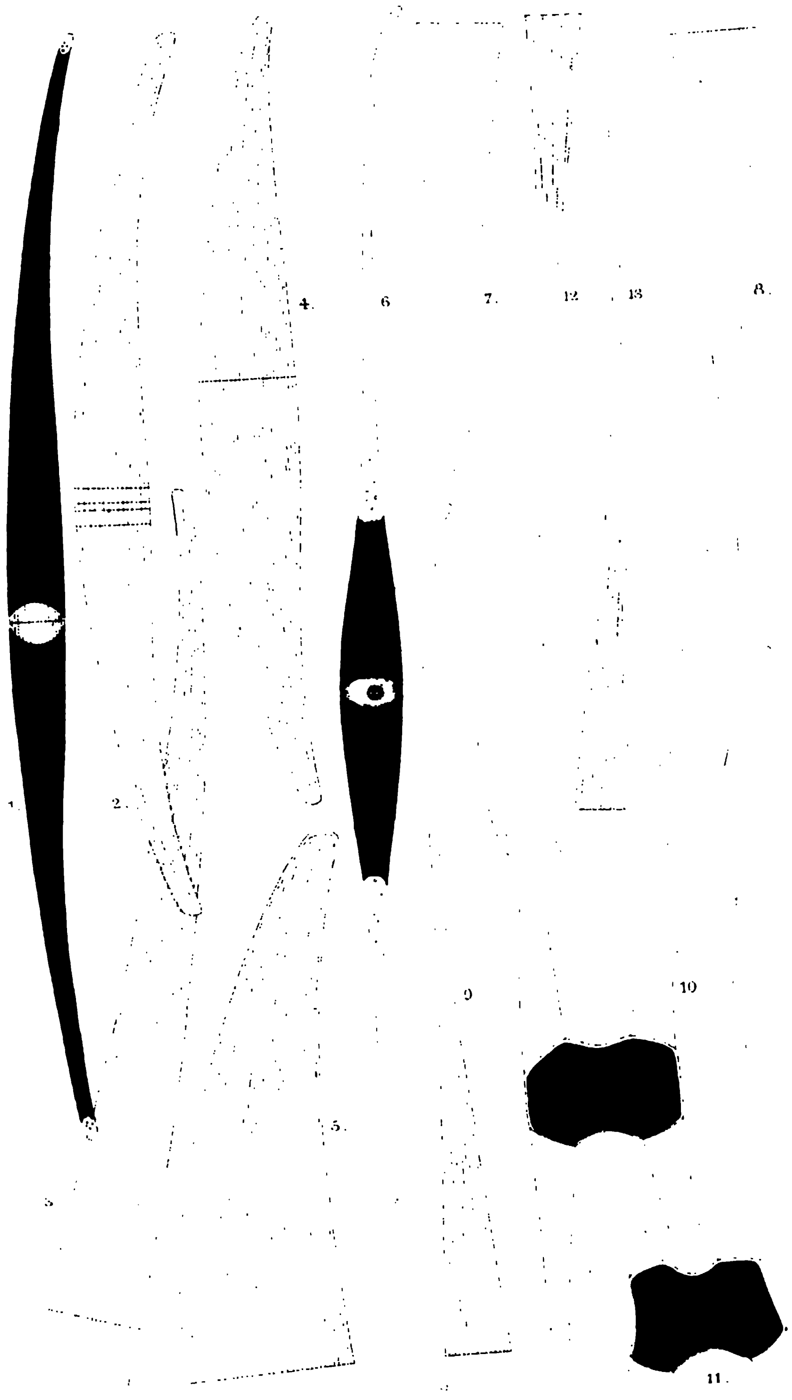
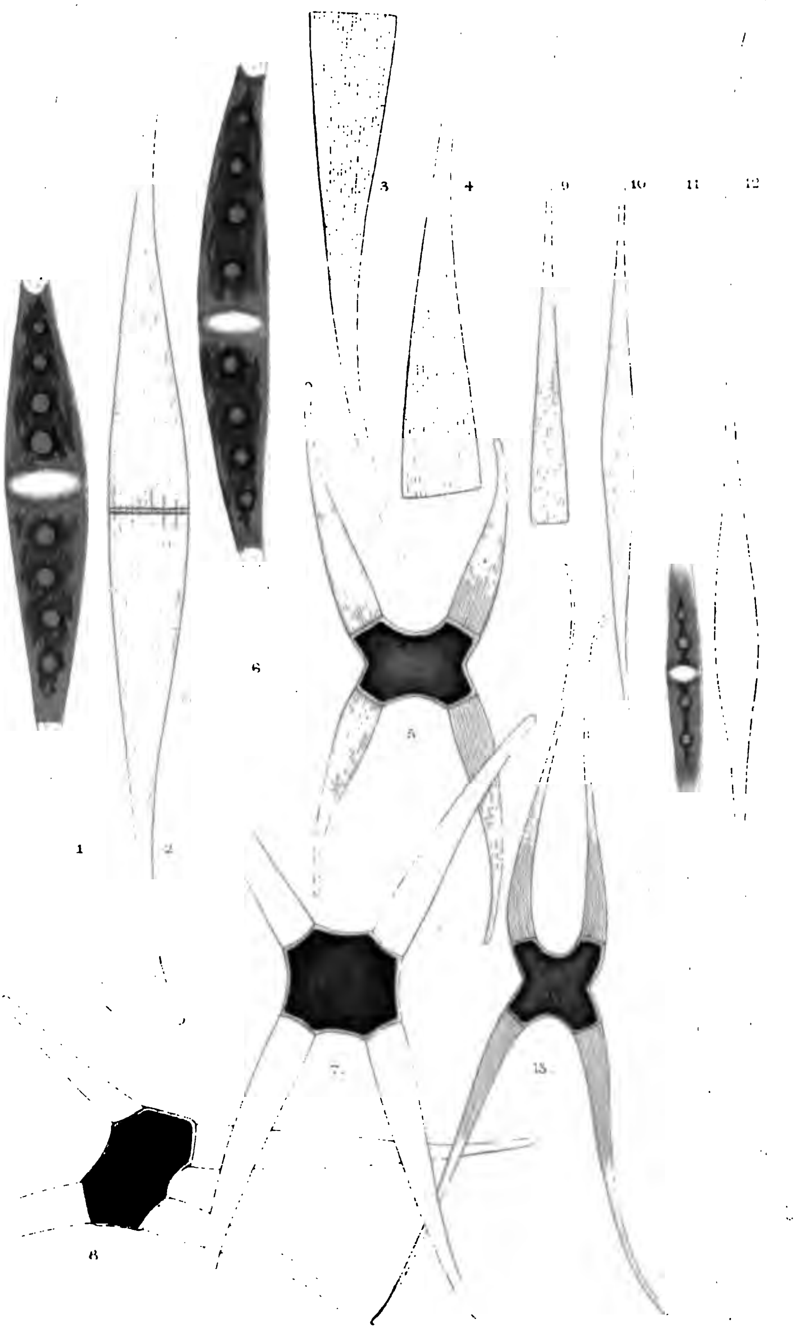


Plate 26

PLATE XXVI.

FIGS.		PAGE
1–5.	—*Closterium rostratum* Ehrenb. 1–4, × 520; 5, zygospore, × 200 (after Ralfs) . .	188
6–8.	—*Cl. rostratum* var. *brevirostratum* West. 6, × 520; 7 and 8, zygospores, × 220 . .	189
9–13.	—*Cl. setaceum* Ehrenb. 9–12, × 520; 13, zygospore, × 400 (after Ralfs) . .	190

PLATE XXVI.



[illegible] [illegible]

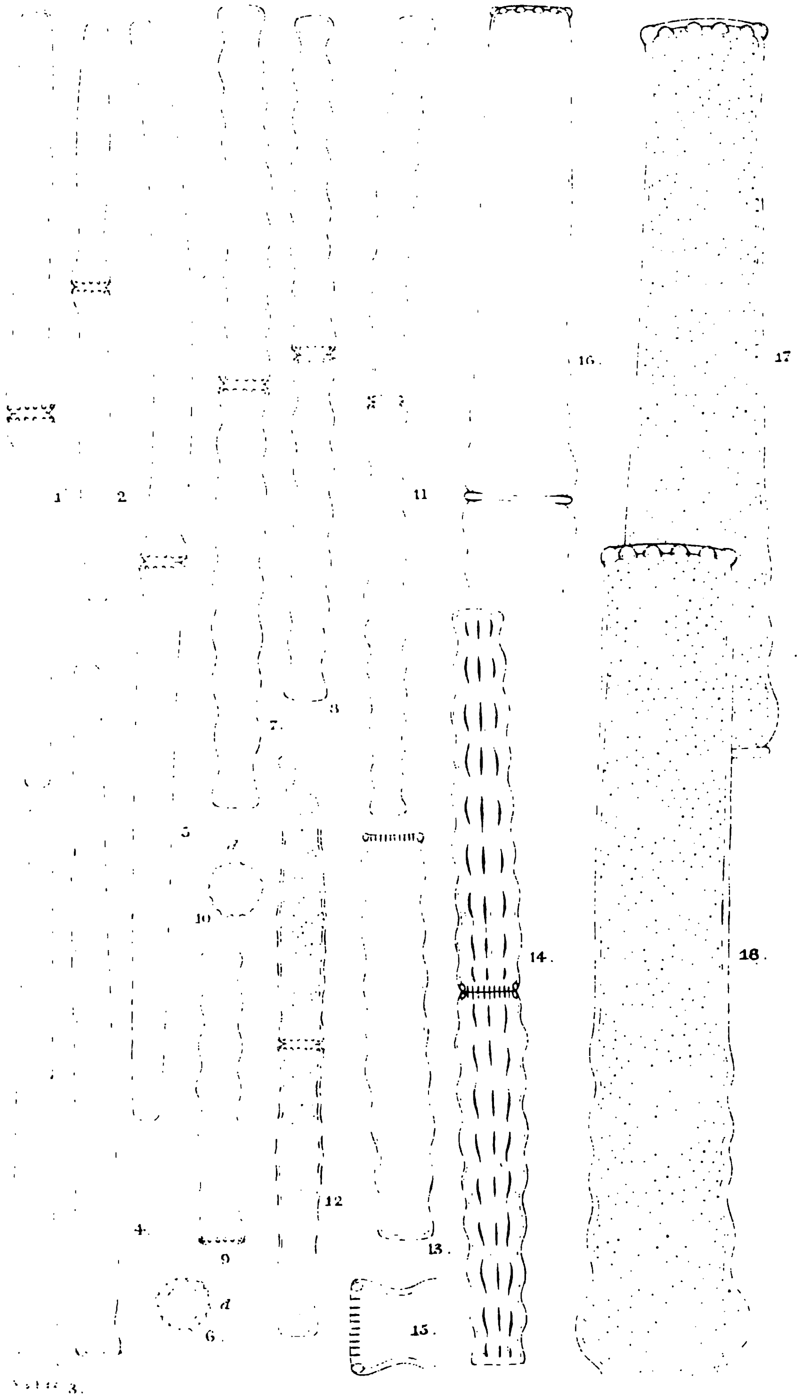
UNI
MO

Plate 27

PLATE XXVII.

FIGS.		PAGE
1–6.	—*Docidium baculum* Bréb. 1, × 430; 2–6, × 520; 6, basal view of semicell, × 520	193
7–10.	—*D. undulatum* Bail. 7, × 430; 8 and 9, × 400; 10, basal view of semicell, × 520	194
11.	—*D. undulatum* forma *perundulata* West & G. S. West. × 400	196
12.	—*D. undulatum* var. *dilatatum* (Cleve) West & G. S. West. × 400	196
13–15.	—*D. nobile* (Richter) Lund. 13 and 14, × 300 (after Richter); 15, base of semicell, × 510 (after Richter)	196
16–18.	—*Pleurotænium coronatum* (Bréb.) Rabenh. 16, × 220; 17 and 18, × 400	199

PLATE XXVII.



[illegible]

UNI
OF
MI

Plate 28

Plate 28

PLATE XXVIII.

FIGS.		PAGE
1–2.—	*Pleurotænium coronatum* var. *fluctuatum* West. 1, × 430; 2, × 400	200
3.—	*Pl. coronatum* var. *robustum* West. × 400	200
4.—	*Pl. coronatum* (Bréb.) Rabenh. × 520. Semicell showing the disposition of the chloroplasts	199
5–8.—	*Pl. coronatum* var. *nodulosum* (Bréb.) West. 5, × 400; 6, × 220; 7 and 8, two apices, × 520	200

PLATE XXVIII.

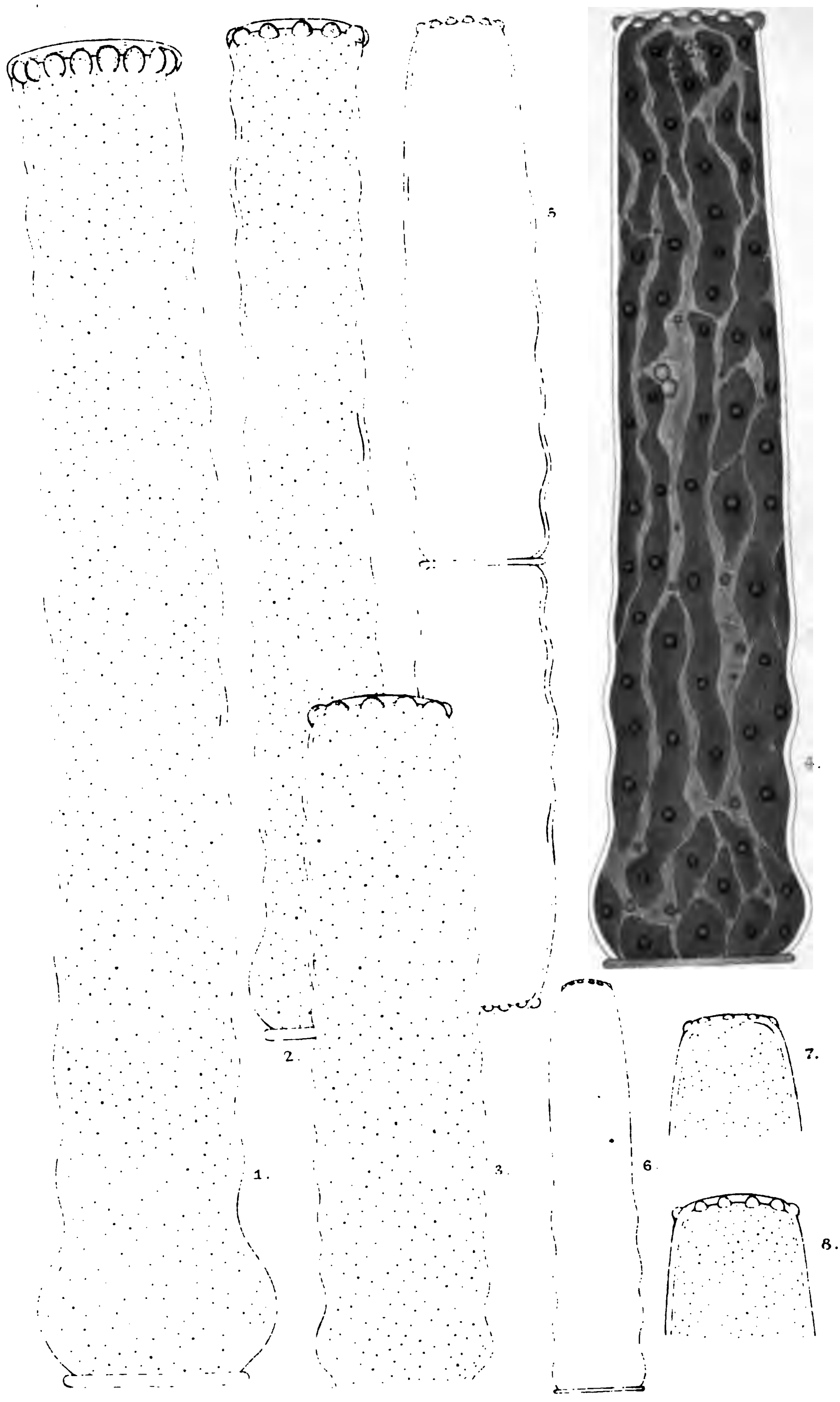


PLATE XXIX

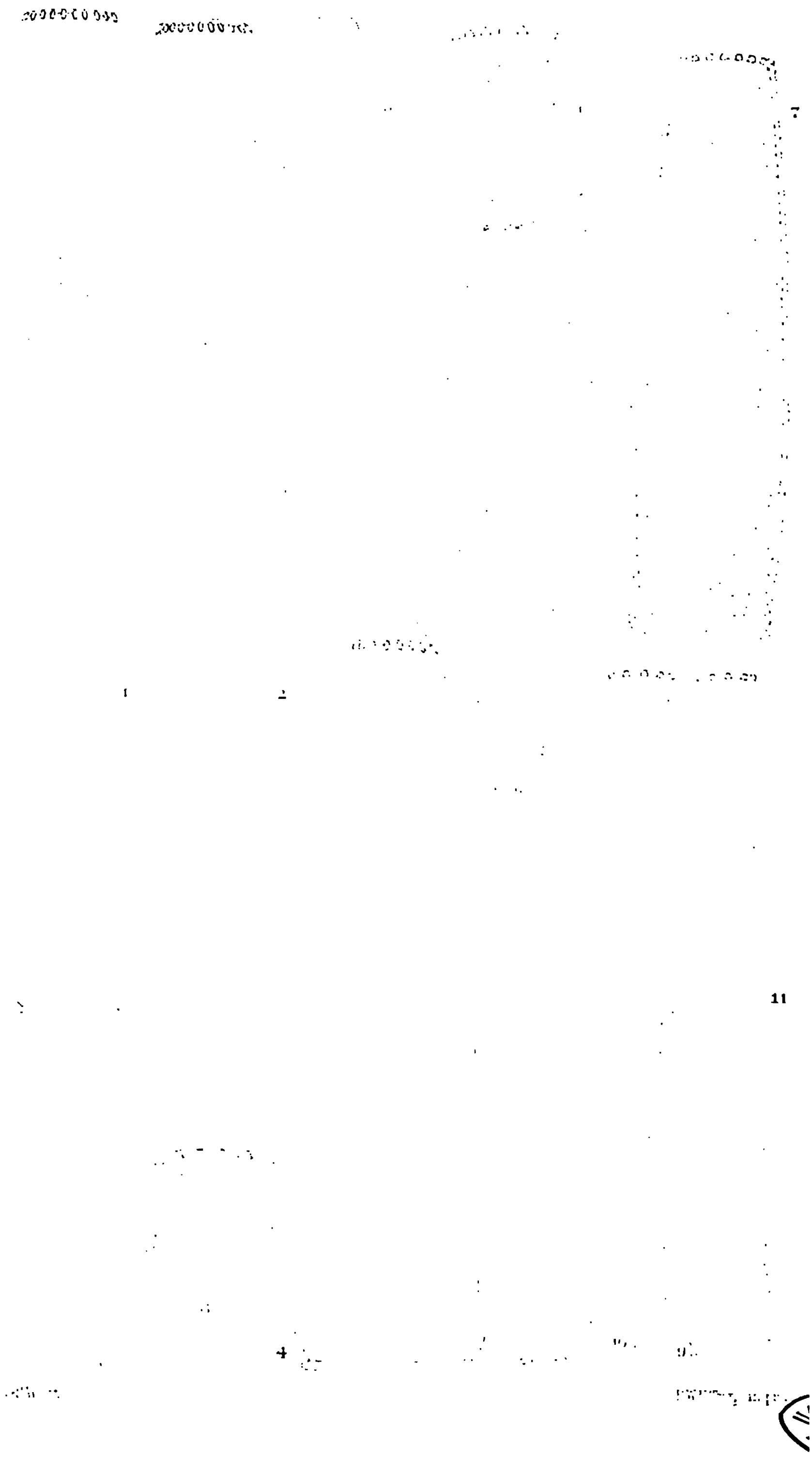


PLATE XXIX.

FIGS.	PAGE
1.—*Pleurotænium eugeneum* (Turn.) West & G. S. West, forma *Scotica* West & G. S. West. × 430 . . .	203
2.—*Pl. eugeneum* forma *Cambrica* West & G. S. West. × 430	203
3–4.—*P. truncatum* (Bréb.) Näg. 3, × 200 (after Ralfs); 4, × 430 . . .	203
5–6.—*Pl. truncatum* var. *Farquharsonii* (Roy) West & G. S. West. 5, × 200 (after Roy); 6, × 530	205
7–8.—*Pl. truncatum* var. *granulatum* West. 7, × 400; 8, apex of semicell, × 400 . .	205
9–11.—*Pl. Ehrenbergii* (Bréb.) De Bary. 9, × 400; 10 and 11, × 520 . . .	205

PLATE XXIX

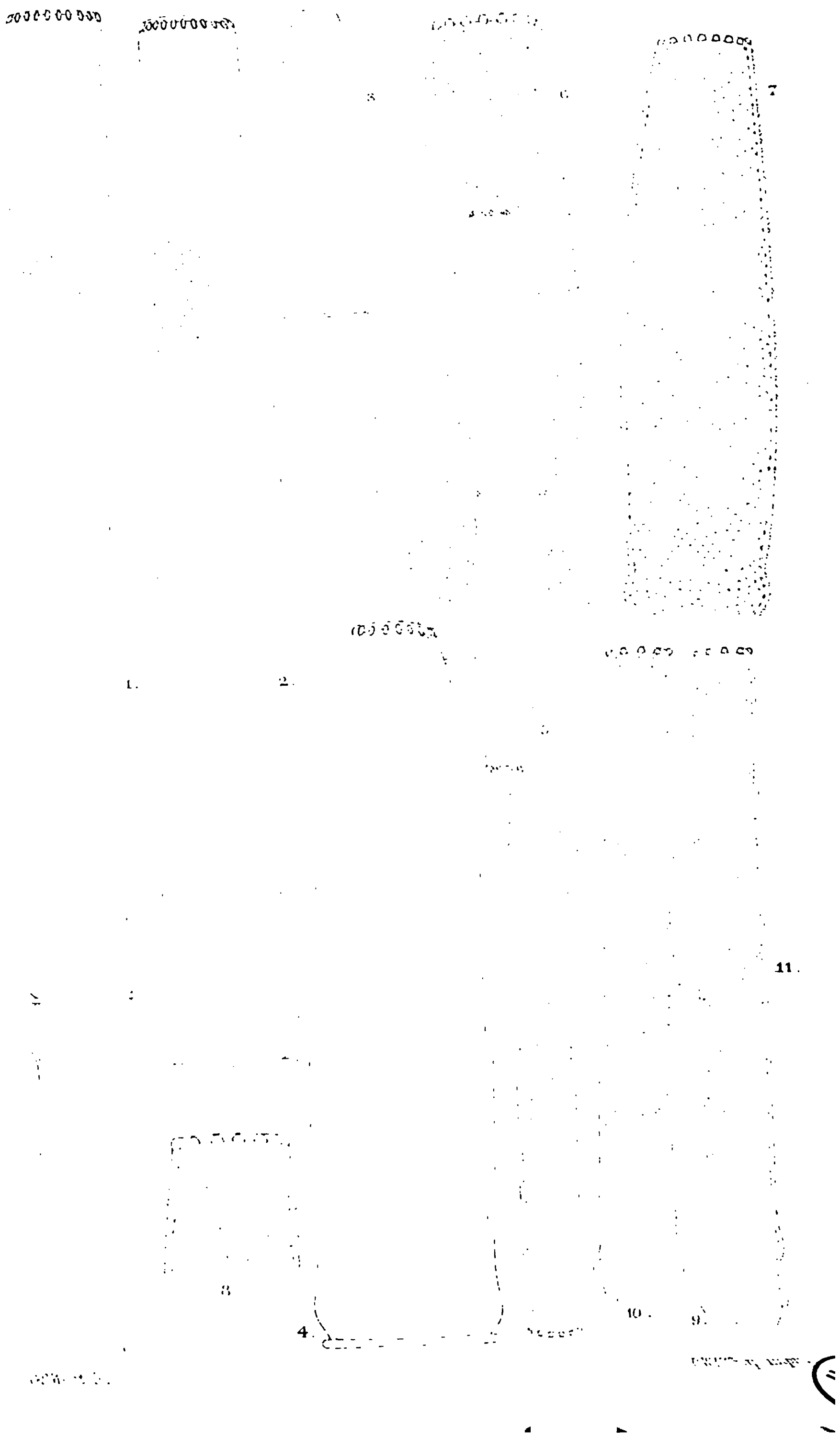


Plate 30

PLATE XXX.

FIGS.		PAGE
1.—	*Pleurotænium Ehrenbergii* (Bréb.) De Bary. Zygospore, × 315	205
2.—	*Pl. Ehrenbergii* forma. × 400	207
3.—	*Pl. Ehrenbergii* var. *elongatum* West. × 400	207
4.—	*Pl. Ehrenbergii* forma. × 220	208
5–6.—	*Pl. tridentulum* (Wolle) West. × 520	208
7–8.—	*Pl. tridentulum* var. *capitatum* West. × 520	209
9–10.—	*Pl. Trabecula* (Ehrenb.) Näg. var. *rectum* (Delp.) West & G. S. West. × 400	212
11–13.—	*Pl. Trabecula* (Ehrenb.) Näg. 11, × 220; 12 and 13, × 500	209
14–15.—	*Pl. Trabecula* var. *rectissimum* West & G. S. West. × 520	212

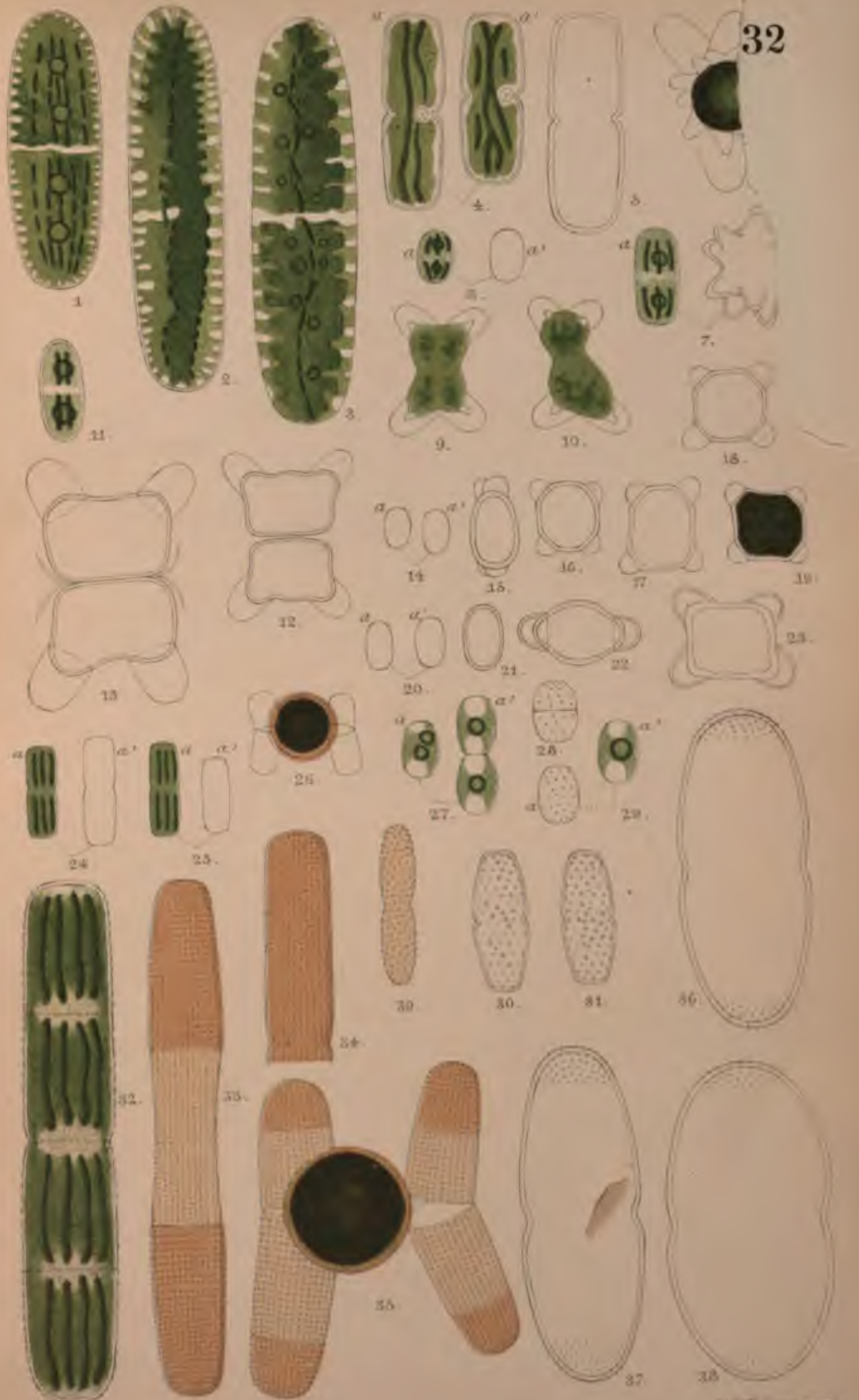
Plate 31

Plate 31

PLATE XXXI.

FIGS.		PAGE
1–2.	—*Pleurotænium maximum* (Reinsch) Lund. 1, × 500; 2, × 520 . . .	213
3–6.	—*Pl. nodosum* (Bail.) Lund. 3 and 4, × 430; 5, basal view of semicell, × 520; 6, × 400 .	214
7.	—*Pl. Hutchinsonii* (Turn.) West & G. S. West. × 400 (after Turner) . . .	214
8–9.	—*Pl. Trabecula* (Ehrenb.) Näg. forma *clavata* (Kütz.) West & G. S. West. 8, × 400; 9, × 200 (after Ralfs) . . .	211

PLA 32



G.S. West del.

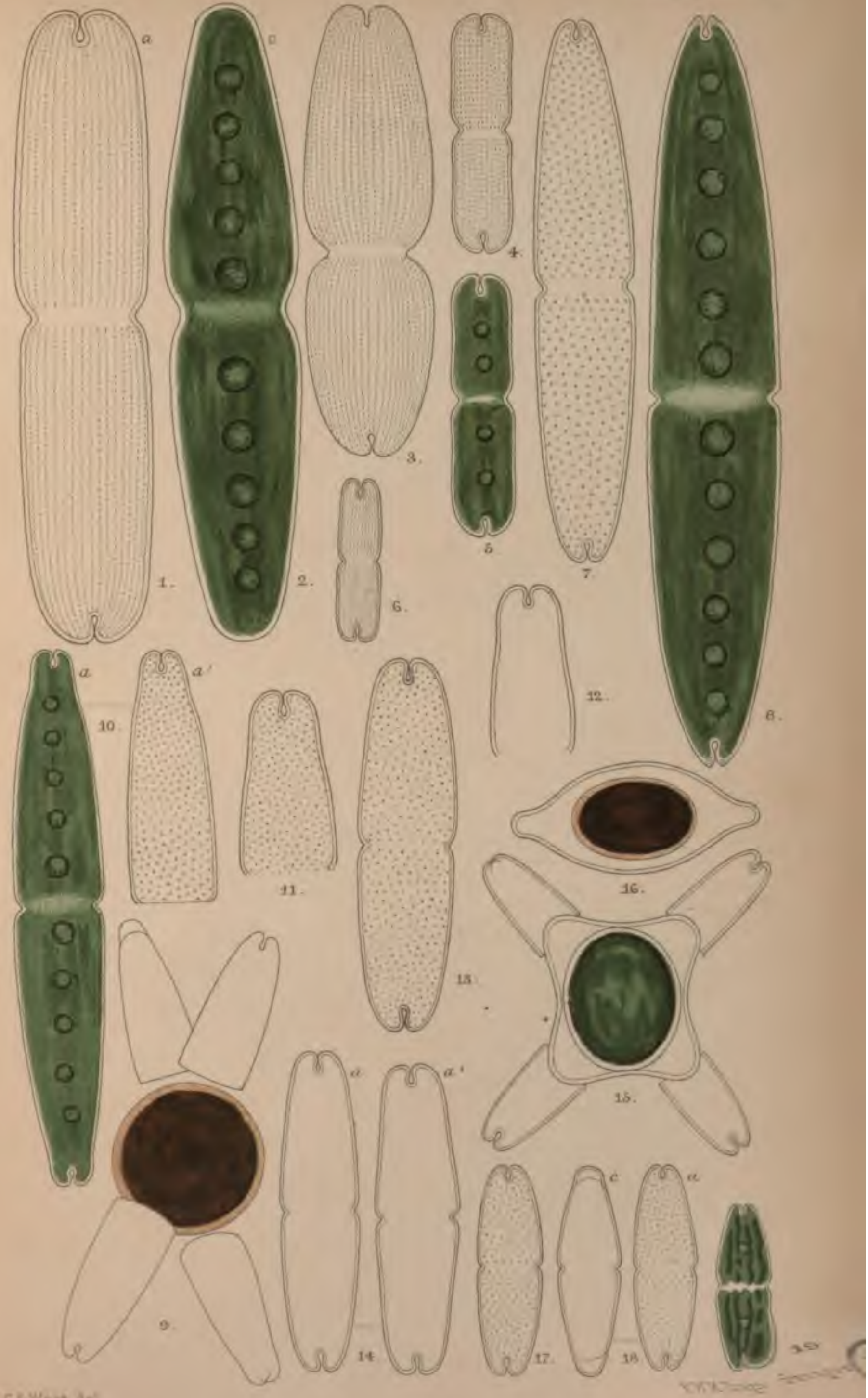
G. W.R. Gray imp.

Plate 32

PLATE XXXII.

FIGS.		PAGE
1–2.	—*Tetmemorus Brébissonii* (Menegh.) Ralfs. × 430	216
3.	—*T. Brébissonii* var. *turgidus* Ralfs. × 400 (after Ralfs)	218
4–5.	—*T. Brebissonii* var. *minor* De Bary. × 430	218
6.	—*T. Brebissonii* var. *minimum* West & G. S. West. × 400	219
7–9.	—*T. granulatus* (Bréb.) Ralfs. 7 and 8, × 430; 9, zygospore, × 315	219
10.	—*T. granulatus* var. *attenuatus* West. × 400	221
11–16.	—*T. lævis* (Kütz.) Ralfs. 11, 12, and 14, × 520; 13, × 430; 15, 16, zygospore (two views), after Ralfs, × 400	222
17–19.	—*T. minutus* De Bary. 17 and 18, × 430; 19, × 390 (after De Bary)	223

PLATE XXXII.



G.S.West del.

[illegible]

RAY SOCIETY

INSTITUTED 1844

FOR THE PUBLICATION OF WORKS ON
NATURAL HISTORY.

ANNUAL SUBSCRIPTION ONE GUINEA.

LIST OF THE SOCIETY

FOR THE YEAR 1904.

CORRECTED TO JUNE, 1904.

OFFICERS AND COUNCIL.

1904—1905.

President.

The Rt. Hon. LORD AVEBURY, D.C.L., LL.D., Pres.Soc.Ant.
For.Sec.R.A., F.R.S., F.L.S., etc.

Vice-Presidents.

ROBERT BRAITHWAITE, M.D., M.R.C.S.E., F.L.S.
ALBERT D. MICHAEL, F.L.S., F.Z.S.
The Rt. Hon. LORD WALSINGHAM, M.A., LL.D., F.R.S.

Council.

Charles G. Barrett, F.E.S.
Rev. Alfred Fuller, M.A., F.E.S.
John Harley, M.D., F.R.C.P., F.L.S.
Sidney F. Harmer, Sc.D., F.R.S.
Prof. W. A. Herdman, D.Sc., F.R.S., F.R.S.E., Pres.L.S.
B. Daydon Jackson, F.L.S.
Albert H. Jones, F.E.S.
Henry Laver, M.R.C.S., F.L.S.
J. W. S. Meiklejohn, M.D., F.L.S.
Rev. Canon Norman, M.A., D.C.L., LL.D., F.R.S.
J. S. Phené, LL.D., F.S.A.
Prof. Edward B. Poulton, M.A., Sc.D., LL.D., F.R.S.
Henry Power, M.B., F.L.S., F.Z.S.
D. H. Scott, M.A., Ph.D., F.R.S., F.L.S., Pres.R.M.S.
Henry Spicer, B.A., F.L.S., F.G.S.
Alfred O. Walker, F.L.S., F.Z.S.

Treasurer.

F. DuCANE GODMAN, D.C.L., F.R.S., F.L.S., F.G.S.

Secretary.

JOHN HOPKINSON, F.L.S., F.G.S., V.P.R.Met.Soc., Weetwood, Watford.

LIST OF THE RAY SOCIETY.

Aberdeen, University of; *King's College, Aberdeen.*

Adkin, Robert, F.E.S.; *Wellfield,* 4 *Lingards Road, Lewisham,* S.E.

Adlard, R. E.; *Bartholomew Close,* E.C.

Advocates' Library; *Edinburgh.*

Andrews, Arthur; *Newtown House, Blackrock, Dublin.*

Army and Navy Club; 36 *Pall Mall,* S.W.

Ash, The Rev. Cyril D.; *Skipwith Vicarage, Selby.*

Athenæum Club; *Pall Mall,* S.W.

Avebury, The Right Hon. Lord, D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., F.Z.S., F.E.S., PRESIDENT; 15 *Lombard Street,* E.C.; 6 *St. James's Square,* S.W.; *and High Elms, Farnborough,* R.S.O., *Kent.*

Baer, Joseph, & Co.; 6 *Hochstrasse, Frankfort, Germany.*

Barrett, Charles G., F.E.S.; *Tremont,* 198 *Peckham Rye,* S.E.

Barrow-in-Furness Public Library; *Barrow-in-Furness.*

Battersea Public Library; *Lavender Hill,* S.W.

Belfast Library; *Donegal Square, Belfast.*

Bentley, Richard, F.S.A., F.L.S., F.R.Met.Soc., F.R.G.S.; *Upton, Slough.*

Berens, A. A., M.A.; *Castlemead, Windsor.*

Bergen Museum; *Bergen, Norway.*

Berlin Royal Library; *Berlin.*

Berlin Royal Zoological Museum; *Berlin.*

Berne Natural History Museum; *Berne, Switzerland.*

Bethune-Baker, George T., F.L.S., F.E.S.; 19 *Clarendon Road, Edgbaston, Birmingham.*

Binks, Mrs. I.; 9 *Burton Street, Wakefield.*

Birmingham Free Libraries; *Birmingham.*

Birmingham Library; *Margaret Street, Birmingham.*

Blackburne-Maze, W. P., F.E.S.; *Shaw House, Newbury.*

Bloomfield, The Rev. E. N., M.A., F.E.S.; *Guestling Rectory, Hastings.*

Board of Education, Secondary Branch; *South Kensington,* S.W.

Bodleian Library; *Oxford.*

Bootle Free Library; *Oriel Road, Bootle, Liverpool.*

Bostock, E. D., F.E.S.; *Holly House, Stone.*

Bostock, F., jun.; *Northampton.*

Bourne, T. W.; *The Wold, Kingskerswell, Newton Abbot.*

Brady, G. Stewardson, M.D., LL.D., F.R.S., Professor of Natural History, Durham College of Science; 2 *Mowbray Villas, Sunderland.*

Braithwaite, Robert, M.D., M.R.C.S.E., F.L.S., Vice-President; 26 *Endymion Road, Brixton Hill,* S.W.

Breslau University Library; *Breslau, Germany.*

Briggs, C. A., F.E.S.; *Rock House, Lynmouth,* R.S.O., *North Devon.*

Briggs, T. H., M.A., F.E.S.; *Rock House, Lynmouth,* R.S.O., *North Devon.*

Brighton and Hove Natural History Society; *Public Library, Brighton.*

Bristol Microscopical Society; 20 *Berkeley Square, Clifton, Bristol.*

Bristol Museum and Reference Library; *Queen's Road, Bristol.*

British Museum; *Bloomsbury,* W.C.

Brockholes, Mrs. J. Fitzherbert; *Clifton Hill, Garstang,* R.S.O., *Lancashire.*

Bromley Naturalists' Society; *Bromley, Kent.*

Brussels National Library; *Brussels.*

Buchan-Hepburn, Sir Archibald, Bart., F.E.S.; *Smeaton-Hepburn, Prestonkirk, N.B.*

Burrows, The Rev. C. R. N.; *Mucking Vicarage, Stanford-le-Hope,* S.O., *Essex.*

Cambridge Philosophical Library; *New Museums, Cambridge.*

Cambridge University Library; *Cambridge.*

Campbell, F. Maule, F.L.S., F.Z.S., F.E.S., F.R.M.S.; *Brynllwydwyn, Machynlleth.*

Canterbury, Philosophical Institution of; *Christchurch, New Zealand.*

Cardiff Free Libraries; *Cardiff.*

Carlyon, T. A.; *Connemara, Darracott Road, Boscombe Park, Bournemouth.*

Chapman, Edward, M.A., F.L.S.; *Hill End, Mottram, Manchester.*

Chapman, T. Algernon, M.D., F.Z.S., F.E.S.; *Betula, Reigate.*

Chawner, Miss Ethel F., F.E.S.; *Forest Bank, Lyndhurst,* R.S.O., *Hants.*

Cheltenham Natural Science Society; *Cheltenham.*

Chester Society of Natural Science; *Grosvenor Museum, Chester.*

Chicago Public Library; *Chicago, Ill., U.S.A.*

Christiania, University of; *Christiania, Norway.*

Church, Sir W. S., Bart., M.D.; 130 *Harley Street,* W.

Clark, J. A., L.D.S., F.E.S.; 57 *Weston Park, Crouch End,* N.

Cleland, John, M.D., D.Sc., LL.D., F.R.S., Professor of Anatomy, University of Glasgow; 2 *The University, Glasgow.*

Congress, Library of; *Washington, D.C., U.S.A.*

Cornwall, Royal Institution of; *Truro.*

Cotton, John, M.R.C.S., F.E.S.; 126 *Prescot Road, St. Helens.*

Crawford, W. C.; 1 *Lockerton Gardens, Colinton Road, Edinburgh.*

Croft, R. Benyon, R.N.; *Fanhams Hall, Ware.*

Croydon Public Libraries; *Town Hall, Croydon.*

Daltry, The Rev. Thomas W., M.A., F.L.S.; *Madeley Vicarage, Newcastle, Staffordshire.*

Davies, A. Ellson, Ph.D., F.L.S., F.C.S.; *Tweedbank, West Savile Road, Edinburgh.*

Derby Free Library; *Wardwick, Derby.*

Detroit Public Library; *Detroit, Mich., U.S.A.*

Devonshire, His Grace the Duke of, K.G., M.A., LL.D., F.R.S., Hon. M.Inst.C.E.; *Devonshire House, Piccadilly,* W., *and Chatsworth, Derbyshire.*

Dickinson, William; *Warham Road, Croydon.*

Downing College; *Cambridge.*

Dublin, Royal, Society; *Leinster House, Dublin.*

§

East Kent Natural History Society; *Medical Hall, Canterbury.*
Eastwood, John E., F.E.S.; *Enton Lodge, Witley, Godalming.*
Edinburgh Museum of Science and Art; *Edinburgh.*
Edinburgh Public Library; *Edinburgh.*
Edinburgh, Royal Society of; *Edinburgh.*
Edinburgh, University of; *Edinburgh.*
Elphinstone, Sir Howard W., Bart., M.A., F.L.S., F.R.G.S.; 2 *Stone Buildings, Lincoln's Inn,* W.C., *and Struan, Wimbledon Park,* S.W.
England, Royal College of Surgeons of *Lincoln's Inn Fields,* W.C.

Fitch, Frederick, F.R.G.S., F.E.S.; *Hadleigh House,* 40 *Highbury New Park,* N.
Fitzgerald, The Rev. H. Purefoy, F.L.S., F.C.S.; *Barracane, Wellington College,* s.o., *Berks.*
Fletcher, W. H. B., M.A., F.E.S.; *Aldwick Manor, Bognor.*
Folkestone Free Public Library and Museum; *Folkestone.*
Foster, C.; *Thorpe, Norwich.*
Fraser, F. J.; 19 *Southampton Street, Bloomsbury,* W.C.
Freeman, Francis F., F.E.S.; *Abbotsfield, Tavistock.*
Friedländer & Sohn; 11 *Carlstrasse, Berlin.*
Fulham Public Library; 592 *Fulham Road,* S.W.
Fuller, The Rev. Alfred, M.A., F.E.S.; *The Lodge, Sydenham Hill,* S.E.

Gascoigne, Major French; *Lotherton Hall, Aberford, Leeds.*
Geological Society of London; *Burlington House, Piccadilly,* W.
Gerold & Co.; *Vienna.*
Gibson, Miss; *Hill House, Saffron Walden.*
Giles, Harry M.; *Zoological Gardens, South Perth, Western Australia.*
Glasgow Natural History Society; 207 *Bath Street, Glasgow.*
Glasgow, Royal Philosophical Society of; 137 *West George Street, Glasgow.*
Glasgow, University of; *Glasgow.*
Godman, F. DuCane, D.C.L., F.R.S., F.L.S., F.G.S., F.Z.S., F.E.S., F.R.H.S., TREASURER; 7 *Carlos Place, Grosvenor Square,* W., *and South Lodge, Horsham.*

Gottingen University Library; *Gottingen, Germany.*

Green, E. Ernest, F.E.S., Government Entomologist; *Royal Botanic Gardens, Peradeniya, Ceylon.*

Grosvenor Public Library; *Buffalo, N.Y., U.S.A.*

Guille-Allès Library; *Guernsey.*

Haileybury College; *Hertford.*

Halifax Public Library; *Belle View, Halifax.*

Harley, John, M.D., F.R.C.P., F.L.S.; *Beedings, Pulborough.*

Harmer, Sidney F., Sc.D., F.R.S.; *King's College, Cambridge.*

Harrison, Albert, F.L.S., F.E.S., F.R.M.S., F.C.S.; *Delamere, Grove Road, South Woodford.*

Harvard University Museum of Comparative Zoology; *Harvard, Cambridge, U.S.A.*

Hastings and St. Leonards Natural History Society; *The Museum, Hastings.*

Heidelberg University; *Heidelberg, Germany.*

Hertfordshire County Museum; *St. Albans.*

Hertfordshire Natural History Society and Field Club; *Upton House, Watford.*

Hilton, James; 60 *Montague Square,* W.

Hood, Donald W. C., M.D.; 43 *Green Street, Park Lane,* W.

Hooker, Sir Joseph Dalton, G.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., F.L.S., F.G.S., F.R.G.S.; *The Camp, Sunningdale, Ascot.*

Hope, G. P.; *Havering Grange, Romford.*

Hopkinson, John, F.L.S., F.G.S., F.R.M.S., V.P.R.Met.Soc., Assoc.Inst.C.E., SECRETARY; *Weetwood, Watford, and* 84 *New Bond Street,* W.

Huddersfield Naturalist and Photographic Society; *The Technical College, Huddersfield.*

Hull Public Libraries; *Hull.*

Hull Subscription Library; *Royal Institution, Hull.*

Ireland, National Library of; *Kildare Street, Dublin.*

Irish, Royal, Academy; 19 *Dawson Street, Dublin.*

Jackson, B. Daydon, F.L.S., General Secretary of the Linnean Society; 21, *Cautley Avenue, Clapham Common,* S.W.

John Crerer Library; *Chicago, Ill., U.S.A.*
Jones, Albert H., F.E.S.; *Shrublands, Eltham.*
Junk, W.; 22 *Rathenowerstrasse, Berlin.*
Justen, Frederick, F.L.S.; 37 *Soho Square*, W.

Kenrick, G. H., F.E.S.; *Whetstone, Somerset Road, Edgbaston, Birmingham.*
Kiel University Library; *Kiel, Germany.*
Kilmarnock Public Library and Museum; *Kilmarnock, N.B.*
King's Inn Library; *Dublin.*

Laver, Henry, M.R.C.S.; 43 *Head Street, Colchester.*
Leeds Philosophical and Literary Society; *The Museum, Leeds.*
Leeds Public Free Libraries; *Leeds.*
Leicester Free Public Library; *Wellington Street, Leicester.*
Lemann, F. C., F.E.S.; *Blackfriars House, Plymouth.*
Lethbridge, Ambrose Y., F.E.S.; *Buckhurst, Wokingham, and Rokeby, Barnard Castle.*
Linnean Society of London; *Burlington House, Piccadilly*, W.
Lister, Arthur, F.R.S., F.L.S.; *Sycamore House, Leytonstone*, N.E., *and High Cliff, Lyme Regis.*
Liverpool Athenæum; *Liverpool.*
Liverpool Free Public Libraries; *Liverpool.*
Liverpool Microscopical Society; 20 *Hackings Hey, Liverpool.*
London Institution; *Finsbury Circus*, E.C.
London Library; 12 *St. James's Square*, S.W.
Longstaff, G. B., M.D.; *Highlands, Putney Heath*, S.W.
Los Angeles Public Library; *California, U.S.A.*
Lyons University; *Lyons, France.*

McIntosh, W. Carmichael, M.D., LL.D., F.R.S.L.&E., F.L.S., Professor of Natural History, University of St. Andrews 2 *Abbotsford Crescent, St. Andrews, N.B.*
McMillan, William Singer, F.L.S.; *Ardenholm, Maghull, Liverpool.*
Magdalen College; *Oxford.*
Manchester Literary and Philosophical Society; 36 *George Street, Manchester.*

Manchester Public Free Libraries; *Manchester.*

Marlborough College Natural History Society; *Marlborough.*

Massey, W. H.; *Twyford,* R.S.O., *Berks.*

Meiklejohn, J. W. S., M.D., F.L.S.; 105 *Holland Road, Kensington,* W.

Melbourne Public Library; *Melbourne, Australia.*

Mennell, H. T., F.L.S.; 10 *St. Dunstan's Buildings, Great Tower Street,* E.C.

Michael, Albert D., F.L.S., F.Z.S., F.R.M.S., F.R.H.S., VICE-PRESIDENT; 9 *Cadogan Mansions, Sloane Square,* S.W., *and The Warren, Studland, Wareham.*

Middlesborough Free Libraries; *Middlesborough.*

Mitchell Library; 21 *Miller Street, Glasgow.*

Munich Royal Library; *Munich, Germany.*

Newcastle-on-Tyne Literary and Philosophical Society; *Westgate Road, Newcastle-on-Tyne.*

Newcastle-on-Tyne Public Library; *Newcastle-on-Tyne.*

New South Wales, Royal Society of; *Sydney, N.S.W.*

Newstead, Robert, A.L.S., F.E.S., Hon.F.R.H.S.; *The Grosvenor Museum, Chester.*

New York Public Library; *New York, U.S.A.*

New York State Library; *Albany, N.Y., U.S.A.*

Noble, Sir Andrew, K.C.B., F.R.S.; *Jesmond Dene House, Newcastle-on-Tyne.*

Norfolk and Norwich Library; *Norwich.*

Norman, The Rev. A. Merle, M.A., D.C.L., LL.D., F.R.S., F.L.S., Hon. Canon of Durham; *The Red House, Berkhamsted.*

Norwich Free Library; *Norwich.*

Nottingham Free Public Libraries; *Nottingham.*

Ontario Agricultural College; *Guelph, Canada.*

Otago, University of; *Dunedin, New Zealand.*

Owens College (Christie Library); *Manchester.*

Paisley Philosophical Institution; 3 *County Place, Paisley.*

Peabody Institute; *Baltimore, Maryland, U.S.A.*

Perthshire Society of Natural Science; *Tay Street, Perth.*

Phené, J. S., LL.D., F.S.A.; 5 *Carlton Terrace, Oakley Street, S.W.*
Philadelphia Academy of Natural Sciences; *Philadelphia, Pa., U.S.A.*
Pickard-Cambridge, The Rev. O., M.A., F.R.S.; *Bloxworth Rectory, Wareham.*
Plowman, T.; *Nystnen Lodge, Bycullah Park, Enfield.*
Plymouth Institution; *Athenæum, Plymouth.*
Porritt, George T., F.L.S., F.E.S.; *Mayfield, Huddersfield.*
Portsmouth Free Public Library; *Town Hall, Portsmouth.*
Poulton, Edward B., M.A., Sc.D., LL.D., F.R.S., F.L.S., F.G.S., F.E.S., Hope Professor of Zoology, University of Oxford; *Wykeham House, Oxford.*
Power, Henry, M.B., F.R.C.S., F.L.S., F.Z.S.; 10A *Chandos Street, Cavendish Square,* W.
Preston Free Public Libraries and Museum; *Preston.*
Pye-Smith, P. H., M.D., B.A., F.R.C.P., F.R.S.; 48 *Brook Street, Cavendish Square,* W.

Quaritch, Bernard; 15, *Piccadilly,* W.
Queen's College; *Belfast.*
Queen's College; *Cork.*
Quekett Microscopical Club; 20 *Hanover Square,* W.

Radcliffe Library; *Oxford.*
Rashleigh, J.; *Menabilly, Par Station,* R.S.O., *Cornwall.*
Reader, Thomas; *Beaufort House,* 125 *Peckham Rye,* S.E.
Ripon, The Most Hon. the Marquis of, K.G., K.C.S.I., D.C.L., F.R.S., F.L.S., F.G.S., F.Z.S.; 9, *Chelsea Embankment,* S.W., *and Studley Royal, Ripon.*
Roberts, Sir Owen, M.A., D.C.L.; *Leybourne, Witley, Godalming.*
Royal Academy of Sciences; *Amsterdam.*
Royal Academy of Sciences; *Stockholm, Sweden.*
Royal College of Science; *Dublin.*
Royal Institution; *Albemarle Street,* W.
Royal Microscopical Society; 20 *Hanover Square,* W.
Royal Society; *Burlington House, Piccadilly,* W.

St. Albans Public Library; *St. Albans.*
St. Andrews University; *St. Andrews, N.B.*

St. Catharine's College; *Cambridge.*

Salford Free Museum and Libraries; *Peel Park, Salford, Manchester.*

Sanders, Alfred, M.R.C.S., F.L.S.; *The Hawthorns, Caterham Valley,* S.O., *Surrey.*

Scharff, R. F., Ph.D., B.Sc., F.L.S., F.Z.S.; *Tudor House, Dundrum,* R.S.O., *co. Dublin.*

Sheffield Literary and Philosophical Society; *Leopold Street, Sheffield.*

Sidney-Sussex College; *Cambridge.*

Sion College Library; *Victoria Embankment,* E.C.

Soar, C. D.; 37 *Dryburgh Road, Putney,* S.W.

Somersetshire Archæological and Natural History Society; *The Castle, Taunton.*

Southport Free Library; *Southport.*

Spicer, Henry, B.A., F.L.S., F.G.S.; 14 *Aberdeen Park, Highbury,* N.

Sprague, T. B.; 29 *Buckingham Terrace, Edinburgh.*

Stazione Zoologica; *Naples.*

Stechert, G. E.; 2 *Star Yard, Carey Street,* W.C.

Stoke Newington Public Libraries; *Church Street,* N.

Stubbins, J.; *Woodlands, Pool, Leeds.*

Sunderland Library and Literary Society; *Fawcett Street Sunderland.*

Terry, C.; *Foxhill Grove, Bath.*

Toronto, University of; *Toronto, Canada.*

Torquay Natural History Society; *Museum, Babbacombe Road Torquay.*

Townshend, Frederick, M.A., F.L.S.; *Honington Hall, Shipston-on-Stour.*

Trinity College; *Cambridge.*

Trinity College; *Dublin.*

Trondhjem, Royal Library of; *Trondhjem, Norway.*

Turner, Sir William, M.B., D.C.L., LL.D., F.R.C.S., F.R.S.L.&E., Professor of Anatomy, University of Edinburgh; 6 *Eton Terrace, Edinburgh.*

University College, London; *Gower Street,* W.C.

Upsala, University of; *Upsala, Sweden.*

Victoria Institute; *Worcester.*

Walker, Alfred O., F.L.S., F.Z.S.; *Ulcombe Place, Maidstone.*
Walker, The Rev. F. A., D.D., F.L.S., F.E.S.; *Dun Mallard, Cricklewood,* N.W.
Walsingham, The Right Hon. Lord, M.A., LL.D., F.R.S., F.L.S., F.Z.S., F.E.S., VICE-PRESIDENT; *Merton Hall, Thetford.*
Warrington Municipal Museum; *Warrington.*
Weg, Max; 1, *Leplaystrass, Leipzig.*
Wesley, E. F., A.K.C.; 28 *Essex Street, Strand,* W.C.
West Kent Natural History Society; *Blackheath,* S.E.
Whittle, F. G.; 3 *Marine Avenue, Southend-on-Sea.*
Wickes, W. D., F.L.S.; 20 *Warrior Square, Southend-on-Sea.*
Wood, J. H., M.B.; *Tarrington, Ledbury.*
Woodd-Smith, Miss B. M., 149 *East India Dock Road, Poplar,* E.

Yale University; *New Haven, U.S.A.*
Yorkshire College; *Leeds.*
Yorkshire Philosophical Society; *Museum, York.*

Zoological Society of London; 3 *Hanover Square,* W.

The Advocates' Library, Edinburgh; the Bodleian Library, Oxford; the British Museum; Cambridge University Library; and Trinity College, Dublin, entered in the List, receive the Society's publications in accordance with the Copyright Act.